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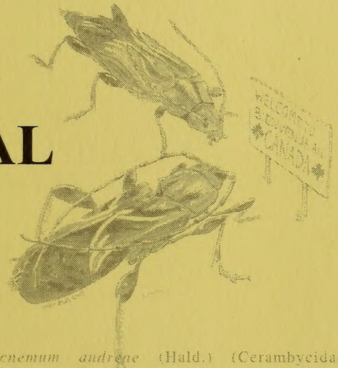
PROCEEDINGS

# of the ENTOMOLOGICAL SOCIETY OF ONTARIO



Physocnemum andreae (Hald.) (Cerambycidae: Cerambycinae) – the cypress bark borer – is an infrequent visitor to Canada. Its only known host, *Taxodium distichum* (L.) – bald-cypress – is found in the southeastern United States. Only a few specimens of this attractive longhorn have been captured in Ontario and Quebec, after having likely emerged from imported logs and piles used in construction. Bruce Gill President-elect of the ESO. Illustration drawn by Martin Damus.

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PROCEEDINGS

of the

ENTOMOLOGICAL SOCIETY OF ONTARIO

Volume 132 *2001*

From the Editor,

Coleoptera and insect biodiversity emerged as the main themes of this issue. With news about Asian longhorned beetles in the northern United States and the brown spruce longhorn beetle in Nova Scotia, a timely assessment of Cerambycidae in Ontario is presented by D.B. McCorquodale. In the second Coleoptera paper, P. Paquin and N. Dupérré present their survey of Quebec's western boreal forest, where 757 species are mentioned along with new records for Quebec, Canada and North America. Two reviews of new books presenting Albertan Cicindelidae and Carabidae of Connecticut are offered. And then, Homopterans are suggested by P. Bouchard et al. as biological indicators of the quality of alvars, rare prairie-like communities that occur on limestone bedrock in the Great Lakes region.

An interesting technique paper by T. Myles shows you how to obtain debris-free termites for many applications, of which my favorite is entomophagy. Integrated pest management for the stripped cucumber beetle feeding on cucumbers, squash and pumpkins is investigated by J.K. MacIntyre et al. who suggest some new recommendations for Ontario. The keen eye of P. Catling uncovered an unusual example of hydridization between two species of damselflies.

I appreciate our cover artist's, M. Damus, talent and sense of humour in welcoming the cypress bark borer to Canada. J. Lupson, our technical editor, is instrumental as always in getting the formatting just right. The scientific review could only be done with a panel of associate editors and anonymous referees. Finally, I acknowledge D. Harmsen, the past editor, who shared his wisdom with me to make this first edition as editor an easier task. It was a pleasure for me to review the fine works of Canadian entomologists in volume 132 of our PESO. I look forward to reading your manuscripts for volume 133.

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NEW RECORDS AND NOTES ON PREVIOUSLY REPORTED SPECIES OF CERAMBYCIDAE (COLEOPTERA) FOR ONTARIO AND CANADA

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Abstract

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Fourteen species of Cerambycidae are reported from Ontario for the first time, including seven new for Canada. Geographically, nine are from the extreme south of the province. Temporally, ten of them are supported by specimens collected only prior to 1970. Four species are included based on old specimens with incomplete collecting data. Concordance with contemporary published reports supports inclusion of these specimens. Finally, notes are included on eight species included on a recent checklist (McNamara 1991) for which no specimens were examined during this study and two species for which the origin of the Ontario specimens is doubtful.

Introduction

A first step to understanding a group is basic information on taxonomy, identification and distribution. The works of Linsley and Linsley and Chemsak (1961–1997) set out these basics for the Cerambycidae of North America. Building on this base, the recent field guide of Yanega (1996) makes it possible to identify virtually all species in eastern North America. Local and regional works can then function to fill in a more detailed picture of distribution. The recent checklist of Canadian beetles records 209 species of cerambycids from Ontario, based largely on the holdings of the Canadian National Collection of Insects, Arachnids and Nematodes and published reports (McNamara 1991). Laplante (1993) records one additional species, *Parelaphidion aspersum,* from Ontario. Checklists are also available for the neighbouring states of Ohio and Michigan and the province of Quebec (Knull 1946; Gosling 1973; Gosling and Gosling 1977; Laplante et al. 1991). These pieces in distributional and taxonomic puzzles, combined with the work on species of economic importance in forestry (e.g. Gardiner 1957, 1975) have resulted in the taxonomy and distribution of species of Ontario Cerambycidae being relatively well known. Recent interest in the potential for economic and ecological problems caused by introduced species, such as the brown spruce long-horned beetle (Forestry Canada 2000; Ontario Ministry of Natural Resources 2000a; Smith and Hurley 2000) and the Asian long-horned beetle (Ontario Ministry of Natural Resources 2000b), has resulted in more surveying of cerambycids in Ontario.

Examination of the Cerambycidae from Ontario in four major insect collections and three smaller ones between 1997 and 1999 revealed 14 previously unrecorded species from Ontario. Eight previously recorded species were not represented in these collections and a further two species are of questionable origin in the province.

Methods

All specimens of Cerambycidae collected in Ontario were examined in four major collections, University of Guelph, Guelph (UOG), Royal Ontario Museum, Toronto (ROM), Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada, Ottawa (CNCI) and Canadian Museum of Nature, Aylmer, Quebec (CMN) and in three minor collections (with respect to Ontario cerambycids), Algonquin Provincial Park Visitors Centre, Algonquin Park (APVC), Canadian Forestry Service — Fredericton, New Brunswick (CFSF) and the Nova Scotia Museum of Natural History, Halifax, Nova Scotia (NSMNH) between 1997 and 1999. Specimens residing in both the Cerambycidae section and in miscellaneous Coleoptera were examined. All specimens were identified using Yanega (1996) supplemented with Linsley (1962a, 1962b, 1963, 1964), Linsley and Chemsak (1972, 1976, 1984, 1995) and Chemsak (1996). Taxonomy and nomenclature follow Yanega (1996).

Label data were recorded for more than 7,500 of the more than 10,000 specimens examined. Old specimens with incomplete collecting information posed a dilemma: possibly exclude valuable specimens or include some specimens of dubious origin. The information on old labels and in old species lists must be used with caution (Lindroth 1969; Shapiro 1998). About 15%, or more than 1,100 specimens, included an indication they were from Ontario, some a location in the province, but lacked a date and often the name of the collector. All of these specimens are considered here. Another several hundred specimens were pinned in a similar fashion and associated with these minimally labeled specimens, but are not considered. Based on comparison of labels of known dates virtually all incompletely labeled specimens from Ontario are from pre-1920 and the vast majority from pre-1900. Many bear labels from Ridgeway, London, Guelph, Ottawa, Toronto or just Ontario. Many, but not all, include a person's name on the label. These names denote the collector in some instances, but may also signify the person in whose collection the specimen resided. The most frequent, in descending order of occurrence, were F.J.A. Morris Collection, W. Saunders, A.H. Kilman, E.B. Reed, A.W.B., E.J. Zavitz, W. Simpson, Wm Brodie Collection, J.M. Denton, OAC Class Collection, Entomological Society of Ontario, and Brimley Collection. I was able to cross-check a few of these specimens in the University of Guelph collection with an Accession Catalogue of the Entomological Society of Ontario for the years 1903 to 1906 to confirm they were indeed collected in Ontario. I have been able also to associate some of these minimally labeled specimens with published reports from the late 1800s (e.g. Reed 1869; Petit 1871; Harrington 1884; Kilman 1889). These associations indicate we should include these specimens in any consideration of the cerambycid fauna of Ontario.

In the list below, collection data are listed in the format: location, date, collector, notes and institution holding specimen. All records represent one specimen unless explicitly stated otherwise. Records are listed chronologically, with specimens lacking a date at the end.

Results and Discussion

I examined more than 10,000 specimens of Cerambycidae from Ontario representing 216 species. Fifteen of these were not included in McNamara (1991), including fourteen not previously reported for Ontario and seven not previously reported for Canada. Of these, four are represented only by old specimens with an indication they are from Ontario, but lacking specific date or locality data. In addition, of the 209 species listed in McNamara (1991) I did not encounter specimens of eight species and only specimens of dubious origin of two others.

Species new for Ontario

Lepturinae

Anthophylax viridis LeConte

Record: Hilton Twp, Tenby Bay, 04 June 1986, J.E. Swann, (ROM).

The type locality of this species is in Keweenaw County, on the northern peninsula of Michigan and this is the only record for the state (Gosling and Gosling 1977). It has been found in Quebec, Nova Scotia and New England (Laplante et al. 1991; McNamara 1991). My perusal of specimens in collections indicates it is more common in New Brunswick and Nova Scotia than Ontario. In Ontario it is likely to be more frequent in central regions, so the collection of the Canadian Forestry Service in Sault Ste. Marie, not seen in this study, may contain additional specimens. The hardwoods, such as birch (*Betula* spp.), beech (*Fagus grandifolia*) and maple (*Acer* spp.), used by the larvae (Linsley and Chemsak 1972) are widespread in central Ontario.

Cerambycinae

Anelaphus pumilus (Newman)

Records: Kent Co., Rondeau PP, 05–10 June 1965, I.M. Smith, black light, (ROM), 7 specimens. Kent Co., Rondeau PP, 19 June 1977, ROM Field Party, black light in forest, Gardiner Trail and Black Oak Trail, 770072, (ROM).

These two collections from Rondeau Provincial Park are the only records for Canada. Gosling (1973) reports it from three southern counties in Michigan and Knull (1946) lists it (as *Elaphidion pumilum*) in Ohio. The larvae feed on a variety of hardwoods (Linsley 1963), such as oak (*Quercus* spp.), and hickory (*Carya* spp.), typical of woodlands in southern Ontario (Hosie 1990). Historically American Chestnut (*Castanea dentata*) may have been an important host.

Obrium maculatum (Olivier)

Record: Ridgeway, no date, no collector, (UOG), 2 specimens.

These were the only Canadian specimens located. This species is listed for Canada in McNamara (1991) without reference to a specific province, and Linsley (1963) says that it occurs in southern Canada. Gosling (1973) recorded it only from Oakland Co. in southern Michigan, and Knull (1946) noted it from Ohio. Larvae feed on a variety of hardwoods, such as oak, hackberry (*Celtis occidentalis*), hickory, and mulberry (*Morus* spp.), which are common and widespread in southern Ontario (Hosie 1990). American Chestnut is also used by the larvae (Linsley 1963), and historically it occurred in southern Ontario (Hosie 1990).

Callidium antennatum Newman

Record: Ridgeway, no date, no collector, (UOG).

The eastern subspecies is *C. antennatum antennatum* Newman. The only Canadian reports are of the western subspecies, *C. antennatum hesperum* Casey from British Columbia (McNamara 1991). Linsley (1964) maps the range of the eastern subspecies as being east of the Appalachians, from New England south to South Carolina and then two outliers in Wyoming and South Dakota. Gosling (1973) and Knull (1946) provide a few reports from southern Michigan and Ohio to fill in some of the intervening area. Larvae feed under the bark of pines (*Pinus* spp.) (Linsley 1964).

Phymatodes maculicollis LeConte

Record: Alfred, 10 June 1984, M. Sanborne, det Laplante, (CMN).

Wickham (1897) included this species in his key to cerambycids of Ontario and Quebec, however no specimens of that vintage were located. The type locality is Isle Royale, Michigan and that remains the only location for the state (Gosling 1973). It has been recorded from Quebec and New Brunswick (Laplante et al. 1991; McNamara 1991), but the bulk of its range is west of Ontario (Linsley 1964), although it is only known from British Columbia and Yukon in western Canada (McNamara 1991). A potential host, balsam fir, *Abies balsamea,* occurs through much of the province (Linsley 1964; Hosie 1990).

Clytus marginicollis Castelneau and Gory

Records: Constance Bay, 27 August 1977, M. Sanborne, det Laplante, (CMN). Owen Sound, 11 June 1978, J.M. Cumming, (UOG).

This species is rarely encountered throughout its range from southern Canada to Florida (Linsley 1964). It occurs in Quebec, New Brunswick and Nova Scotia (Laplante et al. 1991; McNamara 1991) and was recently found in Michigan (Zablotny 1995). Morris (1919) reports collecting a specimen four miles north of Port Hope, Ontario in 1918. However, despite seeing many of his specimens, this one was not found. Zablotny (1995) collected Michigan's first in mid-May and stated that the species is one of the first cerambycids to be active in the spring. The two collections in Ontario suggest the flight season extends through the summer. The larvae feed on pine, with Virginia (*P. virginiana*) and longleaf (*P. palustris*) being mentioned specifically (Linsley 1964). These hard pines do not occur in Ontario. If we assume the larvae feed on hard pines, the most likely hosts in Ontario are Jack pine and red pine and the introduced Scots pine and Austrian pine (*P. banksiana*, *P. resinosa*, *P. sylvestris* and *P. nigra*). Pitch pine (*P. rigida*) is also a potential host, but its range in Ontario does not include either of the collection locations (Hosie 1990). Interestingly, Laplante (pers. comm.) has beaten this species from standing dead balsam fir and spruce logs in Quebec, suggesting that other hosts are used by this infrequently encountered species.

Xylotrechus convergens LeConte

Records: Peel Co., Port Credit, 16 July 1965, I.M and J.M Smith, (ROM), 2 specimens. Windsor, 1984, 04 July 1984, M.T. Kasserra, malaise, (UOG). [Port] Credit, no date, no collector, (ROM).

These are the only records for Canada. It is fascinating to see specimens from the same locality, one from prior to 1920 and others from 1965 and only one other for the province. Both Ohio and Michigan have only one report (Knull 1946; Gosling 1973), suggesting it is not a common insect in these states. Hawthorn (*Cretagus* spp.), which is widespread in southern Ontario (Hosie 1990), is the food plant of the larvae (Linsley 1964).

Lamiinae

Goes tigrinus (DeGeer)

Records: Ridgeway, no date, no collector, (UOG). Ontario, no location, no date, OAC Class Collection, (UOG), 2 specimens. Ontario, no location, no date, no collector, (UOG). Ontario, no location, no date, no collector, (ROM).

Petit (1871) lists it in his collections from Grimsby and this may be one of the minimally labeled specimens either at the University of Guelph or the Royal Ontario Museum. However it may also be a misidentification since *G. debilis, G. pulcher*, and *G. pulverentulus* are not included in that report. All three are expected in that area. Gosling and Gosling (1977) and Knull (1946) provide a few records for Michigan and Ohio respectively. The larvae feed in living heartwood of hardwoods such as oak, walnut (*Juglans* spp.) and hickory (Linsley and Chemsak 1984), all widespread in southern Ontario.

Hebestola nebulosa Haldeman

Records: Pelham, 14 July 1923, W.A. Ross, (UOG). Durham Co., Kendal, 20 July 1967, J.C.E. Riotte, and L.L Kohalmi, uv light, (ROM). Leeds Co., Chaffey's Locks, 17 July 1970, J.C.E. Riotte, uv light, (ROM).

It has been found in Quebec (Laplante 1989), in nine counties in Michigan (Gosling and Gosling 1977, as *Cacoplia nebulosa*) and in Ohio (Knull 1946, as *Cacoplia nebulosa*). Larvae feed on oak, shadbush (*Amelanchier* spp.) and American Chestnut (Linsley and Chemsak 1984). The former two are, and the latter was, widespread in Ontario (Hosie 1990).

Dorcaschema alternatum (Say)

Record: Ontario, no location, no date, A.H. Kilman, (UOG), 2 specimens.

These two are the only Canadian specimens. Gosling and Gosling (1977) include reports from two counties in southwest Michigan. However, Knull (1946) considered it abundant on dead and dying osage orange (*Maclura pomifera*) and mulberry in Ohio. Both osage orange and white mulberry (*Morus alba*) are potential hosts (Yanega 1996) and are extensively planted ornamentals in southern Ontario (Hosie 1990).

Dorcaschema cinereum (Olivier)

Records: Niagara Glen, 26 June 1902, Brimley Coll., (CNCI). Niagara Glen, 28 June 1902, Brimley Coll., (CNCI). Leamington, 24 June 1940, W.J. Brown, (CNCI). Woodslee, 07 August 1976, J.F. Fortin, (UOG).

These are the first reports for Canada. It occurs in Ohio and Michigan (Knull 1946; Gosling and Gosling 1977, as *Hetoemis cinerea*). Larvae feed on a wide variety of deciduous trees, such as hickory, mulberry, hackberry and basswood (*Tilia americana*) (Linsley and Chemsak 1984), which are common and widespread in southern Ontario (Hosie 1990).

Saperda cretata Newman

Records: Ripley Secondary School, 1921, A.P. Gawley, (UOG). Guelph, 27 July 1924, R. Ozburn, (UOG). Windsor, 05 July1929, no collector, (ROM). Ontario, no location, Summer 1930, W.P. Moore, (UOG). Chatham Lab, 07 July 1939, light trap, (CNCI). Guelph, 14 July 1995, B. Jagger, (UOG). London, no date, W. Saunders, (UOG), 2 specimens. London, no date, E.B. Reed, (UOG).

Reed (1869) recounts receiving specimens from a woman in Paris, Ontario, and presumably these are the two undated specimens with his labels in the University of Guelph. This species was included in Wickham's (1897) key to the Cerambycidae of Ontario and Quebec. However, in McNamara (1991), it was only reported from Manitoba. It is known from both Ohio and Michigan (Knull 1946; Gosling and Gosling 1977). Larvae of *S. cretata* feed on hawthorn and apple (*Malus* spp.), both widely available in southern Ontario (Hosie 1990).

Oberea erythrocephalla (Fabricius)

Records: Windsor, 29 June 1979, D.L. Krailo, (UOG). Braeside, 11 June 1987, LeSage and Skidmore, sweeping spurge *E. cyparissias*, (CNCI).

This species was introduced to North America to control leafy spurge *Euphorbia esula*, and is established in the west (Yanega 1996). Yanega predicted it would soon become established in the east. These are the first reports from Canada. It remains to be seen whether it will become established in Ontario.

Tetraopes melanurus Schonherr

Records: Normandale, 24 July 1905, (ROM), 2 specimens. Toronto, 26 June 1925, L. Milne, (ROM). Turkey Point, 24 July 1984, L. Lesage, sweeping in mixed forest, (CNCI). Ontario, no location, OAC Class Collection, (CNCI). London, no date, Ent Soc O, (UOG). London, no date, J.M. Denton, (UOG).

This is the first report for Canada. Chemsak (1963) shows the range extending from southern Maine, south to Florida and then west to Louisiana and north to the northern part of the southern peninsula of Michigan. Chemsak (1963) includes much of southern Ontario in the range of the host plant swamp milkweed, *Asclepias tuberosa*, and therefore as potential range for this species. Gosling and Gosling (1977) reported it from most counties in the northwestern portion of the southern peninsula of Michigan and Knull (1946) noted it in Ohio.

Previously reported from Ontario, no specimens seen

I found no specimens of the following eight species that are listed as occurring in Ontario by McNamara (1991). Listing here is one way of encouraging entomologists to report observations from Ontario.

Prioninae

Prionus imbricornis (Linnaeus)

McNamara (1991) listed it only from Ontario in Canada, however I was unable to locate any specimens, possibly because the specimens were on long term loan from CNCI (Laplante pers. comm). Gosling (1973) does not include any records from Michigan and Knull (1946) states it may occur in Ohio. Chemsak (1996) lists the range as 'eastern North America to Montana and Texas'. The accompanying map includes a location north of Georgian Bay, possibly near Sudbury. Other locations close to Ontario on the distribution map include eastern Minnesota, central Ohio and southern Pennsylvania. The larvae feed on roots of oak, chestnut, plum (*Prunus* spp.) and even grape (*Vitis* spp.) (Linsley 1962a; Chemsak 1996).

Spondylinae

Spondylis upiformis Mannerheim

McNamara (1991) listed it from Ontario, however I was unable to locate any specimens from the province. This species is known in Canada from Quebec (Laplante et al. 1991) and there is one specimen, with limited label data, from Boisetown, New Brunswick in the ROM (pers. obs). Linsley (1962a) and Chemsak (1996) describe the range as 'coniferous forests from Alaska southeast to the Great Lakes region, south into Rocky Mountains and along the Pacific coast'. The closest locations to Ontario are two on the northern peninsula of Michigan (Gosling 1973; Chemsak 1996), two locations in Pennsylvania (Chemsak 1996) and one east of Quebec City (Laplante et al. 1991; Chemsak 1996). Gosling (1973) reports it from two counties in northern peninsula of Michigan, presumably the same two as Chemsak (1996).

Lepturinae

Strangalia famelica Newman

There are two subspecies and it is the one that resides west of the Appalachians, *S. famelica solitaria* (Linsley and Chemsak 1976) that is recorded for Ontario (McNamara 1991). There were specimens from as close to Ontario as Detroit in some collections, yet none from Ontario. Since it is abundant in Ohio (Knull 1946) and southern Michigan (Gosling and Gosling 1977) and the larval food plants include many common flowering shrubs (e.g. *Rosa* spp., *Cornus* spp. and *Spirea* spp.) (Linsley and Chemsak 1976), it is surprising no specimens from Ontario were seen. I expect that focussed collecting will reveal populations in southwestern Ontario.

Typocerus zebra (Olivier)

The similar *T. sparsus* is often misidentified as *T. zebra* (Gosling and Gosling 1977). I saw more than a dozen *T. sparsus* and even a few *Strophiona nitens* that had been identified as *T. zebra*. Linsley and Chemsak (1976) include a location in Prince Edward County on the range map, with the next closest locations being in southern New Jersey and southern Ohio. Gosling and Gosling (1977) could not include it for Michigan and note that a previous record was a misidentified *T. sparsus*. Knull (1946) only specified one collection from Ohio. Given the history of misidentifications it is prudent to remove this species from the Ontario list until better evidence is provided.

Cerambycinae

Parelaphidion incertum (Newman)

Specimens of *P. aspersum* have often been identified as *P. incertum* (Linsley 1963; Laplante 1993; Androw and Keeney 1999). Laplante (1993) clearly demonstrated that previous records in Canada of *P. incertum* were in fact *P. aspersum*. Laplante (1993) explained that the inclusion of *P. incertum* for Ontario and Quebec in McNamara (1991) was based on this misidentification.

Because *Parelaphidion aspersum* (Haldeman) was not included in McNamara's (1991) checklist, all specimens examined are documented here, including the specimens from CNCI that Laplante examined previously.

Parelaphidion aspersum (Haldeman)

Records: Ontario, no location, July 1878, H. Saunders, (UOG). Norfolk, 21 June 1933, J.A. Hall, (UOG). De Cew Falls, 1937, 28 July 1937, S.D. Hicks, (CNCI). De Cew Falls, 1939, 01 July 1939, S.D. Hicks, (CNCI). De Cew Falls, 1939, 22 July 1939, S.D. Hicks, (CNCI). Frontenac Co., Perth Road, 02 September 1971, P. Ward, at bait, (CNCI). Frontenac Co., Perth Road, 09 August 1971, P. Ward, and J. Edsall, (CNCI). Hamilton, 27 July 1982, M. Sanborne, (CNCI). St Catharines, no date, no collector, (CNCI). London, no date, W. Saunders, (UOG), 2 specimens. Edmonton, no date, no collector, (UOG). London, no date, E.B. Reed, (UOG), 2 specimens. Ridgeway, no date, no collector, (UOG).

Parelaphidion aspersum was only recently recognized in Ohio, based on a change in identification of what Knull (1946) called *Elaphidionoides incertum*, to *P. aspersum* (Androw and Keeney 1999). Gosling (1973) records it for eight southern counties in Michigan (as *Elaphidionoides aspersus*). Larvae feed in the outer bark of oak and hickory, especially chestnut oak, *Quercus prinus* and pignut hickory, *Carya glabra* (Linsley 1963). Both these species occur in the vicinity of the sites from Hamilton to Norfolk and along the Niagara peninsula. However, neither occurs in Frontenac Co., nor in the Outaouais of Quebec (Hosie 1990) where Laplante (1993) collected the beetle. Laplante (1993) collected adults on the trunk and branches of red oak (*Quercus rubra*). This oak has an extensive range in eastern Canada (Hosie 1990) and is likely the host in Ontario as well.

Xylotrechus integer (Haldeman)

This species is known from all three maritime provinces and Quebec (Laplante et al. 1991; McNamara 1991). Linsley (1964) describes the range as eastern Canada and northeastern US from New Brunswick to West Virginia. The type locality is in Pennsylvania (Linsley 1964). It is not recorded from Ohio and Michigan (Knull 1946; Gosling 1973). Ontario would be on the western edge of the range. Larvae feed on balsam fir and hemlock (*Tsuga canadensis*), both common and widespread in Ontario (Hosie 1990). No specimens from Ontario were seen during this study.

Tilloclytus geminatus (Haldeman)

Linsley (1964) includes Ontario in the description of the range. This may be the source of the inclusion of Ontario by McNamara (1991). The type locality is in Pennsylvania and the range includes parts of the northeastern US (Linsley 1964). Gosling (1973) included no records for Michigan and Knull (1946) states 'it will occur in Ohio'. Host plants include several components of the flora of Ontario, such as Mockernut Hickory (*Carya tomentosa*), white oak (*Quercus alba*), gums (*Nyssa* spp.) and eastern flowering dogwood (*Cornus florida*) (Hosie 1990). No specimens from Ontario were seen during this study.

Elytroleptus floridanus (LeConte)

Linsley (1962b) lists the range as the Atlantic coast from southern Canada to Florida. This may be the basis for inclusion in McNamara (1991). It was not recorded in Ohio and Michigan (Knull 1946; Gosling 1973). No specimens were seen during this study.

Previously recorded from Ontario, of questionable origin

Prioninae

Prionus fissicornis Haldeman

Record: Sudbury, no date, no collector, (CNCI).

The above minimally labeled specimen is presumably the basis for inclusion for Ontario in McNamara (1991). This is the only record for Canada. It was not recorded for Ohio or Michigan (Knull 1946; Gosling 1973). The distribution maps in Linsley (1962a) and Chemsak (1996) show the range largely west of 100th meridian. The furthest east locations are in western Minnesota, central Iowa and western Missouri. I suspect this specimen was either mislabeled or transported to the area. Given the large gap between Sudbury and the normal range of this species and the limited data on the label, it seems prudent to delete this species from the Ontario list. It is also possible that this specimen is the source of the Ontario dot on the distribution map of *P. imbricornis* in Linsley (1962a) and Chemsak (1996).

Cerambycinae

Physocnemum andreae (Haldeman)

Record: Grimsby, 04 June 1913, Brimley, (CNCI).

The above is one of three records for Canada, the others are from Quebec (Linsley 1964; Laplante 1989; McNamara 1991). Laplante (1989) argues that this species should be considered an accidental introduction, not part of the native cerambycid fauna. The same arguments apply to Ontario and, therefore, I think it should not be on the Ontario list. All other records of *P. andreae* are within the range of the larval host, bald cypress, *Taxodium distichum* (Linsley 1964; Brockman 1968). Neither the distribution of the host nor the remainder of the distribution of the beetle approaches Ontario.

Final comments

Old specimens with limited collecting data provide support for the addition of seven of 14 species to the list of Cerambycidae for Ontario. These old specimens provide the only support for four of these species. A valid question is: should the species supported only by old specimens with limited data be included on a list of Ontario Cerambycidae? I have been able to make associations between specimens and contemporary reports for species such as *G. tigrinus* and *S. cretata* (Reed 1869; Petit 1871), and I have been able to find other written records of the time mentioning collecting the species (e.g. Wickham 1897). The weight of evidence is that they should be included.

Eight of the 14 additions are from extreme southern Ontario, particularly along Lake Erie, and, to a lesser extent, the north shore of Lake Ontario. Most depend on Carolinian hardwood trees (e.g. hickory, oak and, historically, chestnut) that have a restricted distribution in southern Ontario. Another species, *Tetraopes melanvrus*, also has a southern distribution differing only in having a herbaceous host plant, swamp milkweed. At least three of these species (*Obrium maculatum, G. tigrinus, D. alternatum*) have not been collected in the past 50 years, and all others are represented by only one to three collections over the same time period. Given changes in forest distribution, the paucity of specimens and the length of time between collections, some may warrant conservation attention. Another possibility is that beetle collectors rarely frequented the areas where these beetles are in the past 50 years.

It is of interest that ten of the species newly recorded for Ontario here were represented in collections with specimens from prior to 1970, and eight of these from specimens from prior to 1930. This suggests that careful examination of present holdings in Ontario collections would go a long way to preparing a basic inventory of species in the province.

Insect collections usually have a geographical focus. The University of Guelph collection focuses on rural southern Ontario. It has been the repository of student insect collections from southern Ontario for more than 100 years, includes the original Entomological Society of Ontario collections from the late 1800's, the Vineland Research Station collection and is the repository of several major parks surveys. The value of this material is demonstrated through housing 11 of the 14 newly recorded species. The Royal Ontario Museum also has significant holdings from southern Ontario as shown by containing seven of the newly recorded species from the province. McNamara's (1991) list was derived largely from the Canadian National Collection of Insects (CNCI) of Agriculture Canada in Ottawa and hence only four of the newly recorded species were in this collection. The recently established Canadian Museum of Nature collection contains relatively few specimens from Ontario and hence only two of the newly recorded species. Each of the collections has different historical and geographic strengths in Cerambycidae and therefore all need to be considered to document fully the fauna of Ontario. Even large national collections can have a local bias, therefore examination of regional collections can counteract this effect.

Finding non-native cerambycids such as the Asian long-horn (*Anoplophora glabripennis*) in New York and the brown spruce long-horn (*Tetropium fuscum*) in Halifax, NS (Haack et al. 1997; Forestry Canada 2000; Ontario Ministry of Natural Resources 2000a, b; Smith and Hurley 2000) in the past decade has resulted in a media blitz concerning the potential economic and ecological problems establishment may cause. Surveying collections and producing provincial lists are a necessary part of the ongoing vigilance required to detect newly introduced species. Here, one recently introduced species, *Oberea erythrocephala*, was detected, introduced into North America for biocontrol of spurge. Whether it will establish viable populations remains to be seen.

Several distinctive floristic areas in Ontario are either inadequately represented or completely lacking in cerambycid collections I examined. Specifically I saw no specimens from Lake of the Woods, Rainy River, or the James Bay lowlands. More thorough collecting in areas of Ontario not adequately represented in the four main collections I examined will undoubtedly add several new cerambycids to the fauna of Ontario.

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THREE EXTRACTION DEVICES FOR RAPID SEPARATION OF LARGE NUMBERS OF LIVE TERMITES (INSECTA: ISOPTERA)

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Abstract *Proc. ent. Soc. Ont.* 132: 15–25

Three devices are described for separating subterranean termites, *Reticulitermes flavipes* (Kollar), from cardboard roll traps and soil. The first device, an extraction hopper, separates termites from cardboard roll traps as well as the removal of coarse debris. The extraction hopper is a large, legged funnel, constructed of galvanized sheet metal with a removable top screen; the bottom of the funnel connects to a stack of standard soil sieves. The second device, a baffle separator, provides for rapid separation of termites from soil after coarse sieving. When termites and soil are passed alternately at three-minute intervals between two baffle separators, 96.4% of the termites can be extracted from the soil within 15 minutes. The third device, a tray-in-box separator, has a similar function as the baffle separator, requires less manual processing time, but a longer waiting period to complete the separation. These three devices make it possible to efficiently obtain millions of debris-free, live termites which can then be used for various purposes such as experimentation, as vectors of control agents, or as animal feed for insectivores.

Résumé *Proc. ent. Soc. Ont.* 132: 15–25

Trois appareils sont décrites pour la séparation des termites à pattes jaunes, *Reticulitermes flavipes* (Kollar), de pièges en carton roulé et du sol. Le premier appareil est une trémie d'extraction en forme d'entonnoir sur des jambes et est construite de tôle galvanisé, surmonté d'un tamis détachable. Le fond de l'entonnoir est branché à une série de tamis. Cet appareil sépare les termites des pièges en carton roulé et enlève le débris grossier. Le deuxième appareil est un séparateur-déflecteur, qui sépare rapidement les termites du sol après avoir été passer au tamis. Quand les termites et sols sont passer alternativement à des intervalles de trois minutes entre deux séparateurs-déflecteurs, 96.4% des termites sont extraits du sol après 15 minutes. Le troisième appareil, qu'on appelle un séparateur-plateau-dans-boîte, demande moins de traitements manuels que le séparateur-déflecteur, mais il demande plus de temps pour la séparation complete. Ces appareils extraient efficacement un grand nombre de termites vivants sans debris, qui pourraient servir comme sujets d'experiences, vecteurs d'agents de lutte, ou même comme aliment pour les animaux insectivores.

Introduction

Methods for trapping and baiting subterranean termites (mainly Rhinotermitidae) have been developed and improved upon by various researchers. Trap substrates for termites have ranged from such items as bundles of wooden strips (Tamashiro et al. 1973), solid or rotten wooden blocks, (Beard 1974; Esenther and Beal 1979; Su et al. 1996), wood slats (Miller 1994), toilet paper rolls (La Fage et al. 1973; French and Robinson 1981), cardboard "sandwiches" (Esenther 1980) and cardboard rolls (La Fage et al. 1983; Grace 1989). Containers for these bait substances have included plastic containers and buckets (Su et al. 1993, 1995), wooden bait boxes (French 1994,) hollow stakes (Ewart et al. 1992), above-ground and below-ground perforated tubes and commercial bait stations (Grace et al. 1995; Su et al. 1995), 54 or 200 litre steel drums (Miller 1994), and polyvinyl chloride (PVC) pipes used as "sleeves" around the bait (French and Robinson 1981; La Fage et al. 1983, Lewis et al. 1998). Although numerous researchers have investigated and improved upon methods of trapping and aggregating subterranean termites, few accounts exist of methods to extract termites from substrate debris, and the methods that have been reported are either slow, labour intensive, or low yielding. Gay et al. (1955) described the classical method of "papering off", in which termites migrate from dry paper towels to moist paper towels after being manually removed from split logs or stumps; this method is still in widespread use. Becker (1969) noted that when small, debris-free groups of termites are needed, flexible forceps or hand aspirators could be used to manually collect the termites desired in the exact caste composition required. Tamashiro et al. (1973) proposed a method by which termites migrate from their substrate to a clean block of wood by crossing over damp wooden tongue depressors. Jones and Mauldin (1983) described a method of improved aspiration of large numbers of live termites by attachment of an aspirator to a small electric canister vacuum cleaner. Ewart (1985) gave a method for separating termites from nest debris involving the use of a fine-mesh sieve, to which the termites clung, while the debris was filtered away.

New approaches for termite control have required the collection of large numbers of termites to act as vectors of control agents (Tamashiro et al.1973; French 1991, 1994; Myles 1994, 1996; Myles et al. 1994). To use termites as vectors it is desirable to collect as many termites as possible and to extract them from their substrate as efficiently as possible with the least amount of termite injury. Tamashiro et al. (1973) devised methods for trapping substantial numbers of subterranean termites and separating them from debris with the intention of using the collected termites as vectors of pathogens. French (1991, 1994) developed the bait box technique in which a variety of bait containers are used to attract and aggregate termites prior to treatment with toxic dust. Myles (1994, 1996) developed a somewhat similar system called the Trap-Treat-Release technique, in which trapped termites are treated with a transmissible toxic coating before being released back into the colony. During the course of field trials of this method, conducted in Toronto, it became necessary on a daily basis to extract tens of thousands of termites from traps, debris, and soil. Three devices were developed to facilitate the process.

Materials and Methods

Extraction Hopper for Coarse Extraction of Termites

The first device, used in the separation of termites from coarse debris, is an extraction hopper (Fig. 1). It is constructed of galvanized sheet metal, measuring 115 cm in length by 75 cm in width by 95 cm in height. A removable screen of 12 mm mesh, 15 cm in depth, is fitted onto the upper part of the hopper to retain coarse debris such as large clods of soil and pieces of corrugated cardboard. Below the screen, the extraction hopper is tapered at an angle of 45°, forming a funnel 67.5 cm in length. At the bottom of the extraction hopper, is a circular opening, 20.5 cm in diameter, permitting a stack of standard soil sieves (W.S. Tyler, St. Catharines, Ontario, Canadian Standard sieve series) to fit snugly beneath. The termites and some debris are caught on the No. 20 sieve and the coarser material on the Nos. 4, 5, 6 and 7 sieves. Fine material caught in the bottom pan is discarded. The termites and remaining debris in the No. 20 sieve may then be transferred to either the baffle separator or the tray-in-box separator for final separation of the termites from the remaining fine debris.

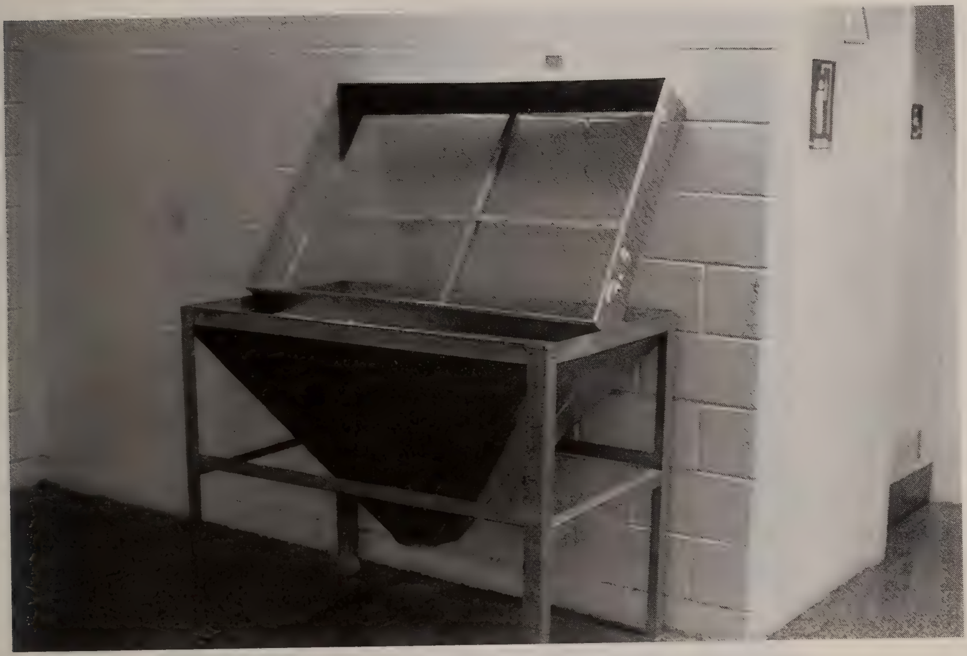

FIGURE 1. Extraction hopper with removable upper screen in raised position.

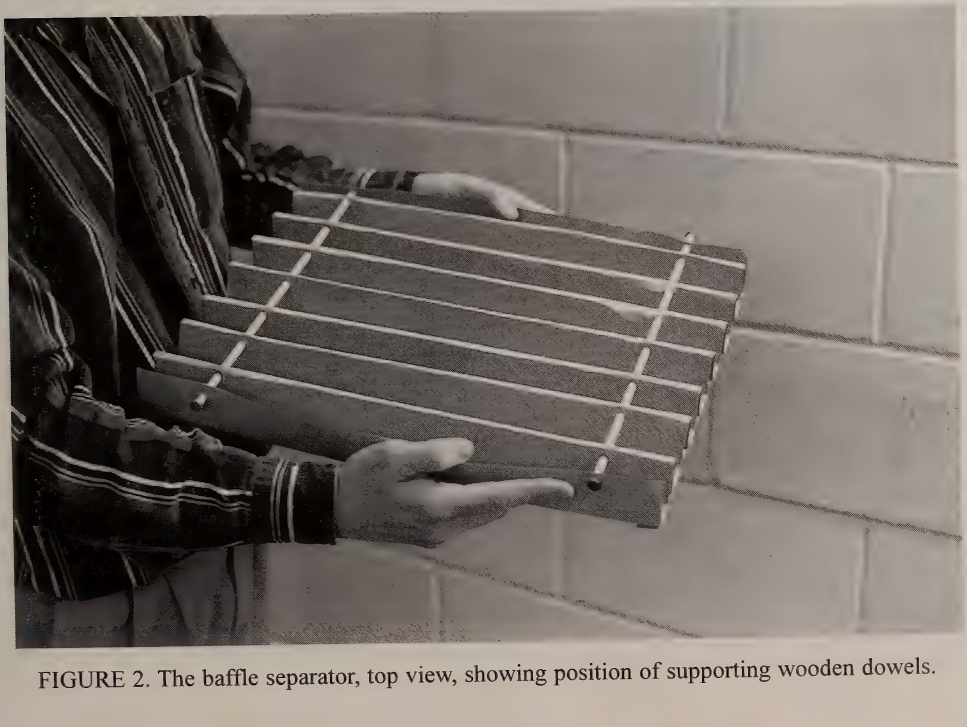

FIGURE 2. The baffle separator, top view, showing position of supporting wooden dowels.

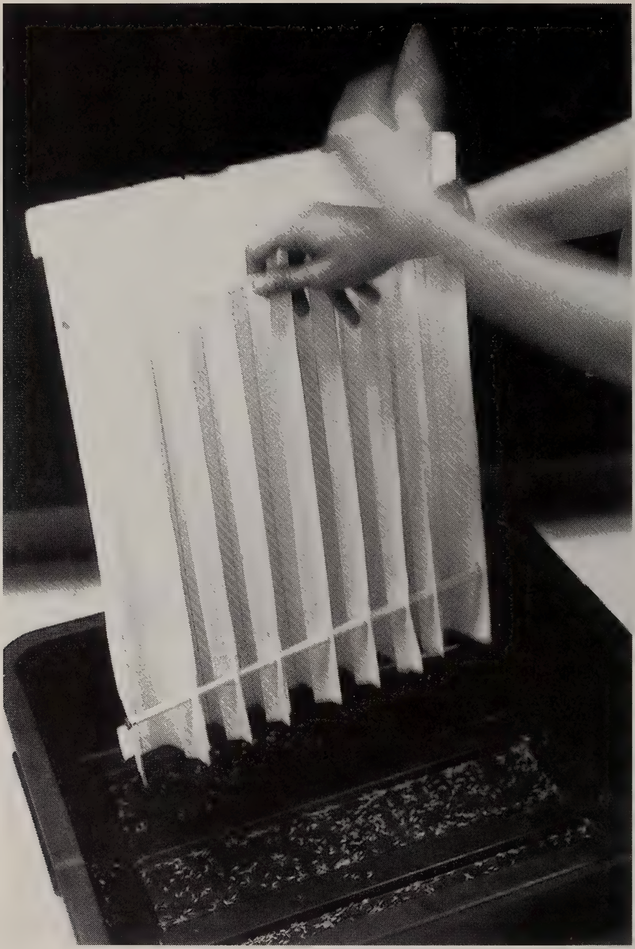

FIGURE 3. Method of dislodging termites clinging to the baffle separator.

Baffle Separator for Removal of Fine Debris and Soil

The baffle separator consists of a sheet of folded blotting paper secured with two dowels (Fig. 2). A sheet of blotting paper, 44 cm wide and 87 cm long, is folded to form ridges 3.5 cm high and 1.0 cm wide, with intervening spaces 3.0 cm wide. The wide floor space provides maximum settling area for the soil. Two wooden dowels, 5 mm in diameter and 36 cm long, are pierced through holes cut with a cork borer or a large hole punch in the upper third of the raised folds, and are placed 33 cm apart. To maintain the raised folds in position, two narrow strips of blotting paper, 36 cm by 2 cm, are stapled on the ventral surface, along the lateral edges and perpendicular to the folds, with the staples placed in between the ridges.

During the process of separation, the termites and debris are passed alternately, at intervals, between two baffle separators, as follows. The first baffle separator is placed inside a plastic box, 50 cm long by 42 cm wide by 12 cm deep. Termites and soil obtained from the extraction hopper and collected in sieve No. 20 are then spread evenly on top of this baffle. A waiting period of

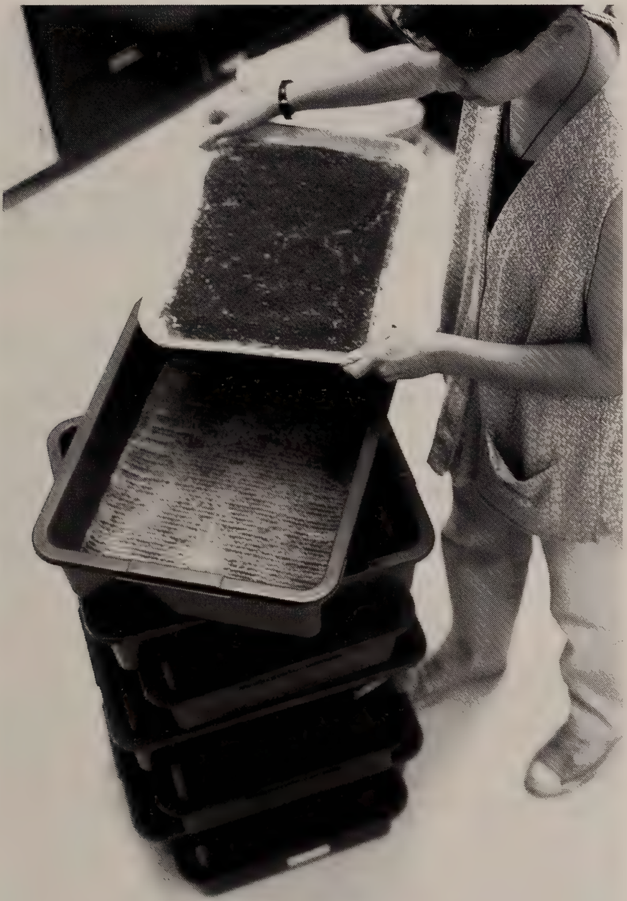

FIGURE 4. A stack of tray-in-box separators.

several minutes is allowed to elapse, during which the termites crawl off the soil and onto the walls of the baffle extractor. When the number of termites walking off the soil and onto the baffle begins to reach an equilibrium with the number that are walking from the baffle back onto the soil, the soil needs to be passed to a second baffle separator. The first baffle extractor is lifted by the dowels from the tray and the soil is gently poured onto a second baffle extractor, placed in another tray. After the soil is transferred to the second baffle extractor, the termites still clinging to the first extractor are dislodged into a clean container by using one hand to rap the back of the other hand, which holds the upper dowel, held horizontal to the container (Fig. 3).

Tray-in-Box Separator for Soil Removal

In a third extraction device, a tray-in-box separator, the edges of a tray are covered with masking tape to provide a textured surface allowing termites to climb over the tray edges (Fig. 4). Two sheets of damp corrugated cardboard, cut to fit plastic boxes, 50 cm by 42 cm, and 12 cm deep, are placed on the bottom of the box, such that the corrugations on the lower sheet faced down, and those of the upper sheet faced up. Soil and nest debris containing termites are placed on the tray and spread out evenly. The tray is of such a size that it fits the box closely, but leaves at least a few millimeters of space around the edges or corners to enable the termites to crawl over the edges of the tray and into the damp cardboard below on the floor of the box. Under typical operation, a stack of tray-in-box separators are left overnight to allow time for the soil to dry out and for the termites to move off the trays and onto the damp layers of corrugated cardboard below. The following day, the soil is dumped off the trays and the clean termites are then shaken from the damp cardboard sheets.

Evaluation of Extraction Procedure

Termites were collected in cardboard roll traps from 14 different sites around Toronto. When termites were found to be present in the traps, the cardboard roll was removed with the termites and taken to the laboratory in a sealed plastic container. The roll traps were shaken into the hopper for coarse sieving. Termites and soil then were transferred to the baffle separator. After waiting periods of three minutes' duration, the baffle extractor was raised from the tray, and the soil with remaining termites was gently poured onto a second baffle separator and the clinging termites were dislodged from the first baffle separator and weighed. This procedure of transferring soil and termites was repeated at three-minute intervals five times, for the termites trapped from each of the 14 sites.

Results

The Devices

The dimensions of the extraction hopper are designed so that one to six individuals can stand at the sides of the hopper and work simultaneously to unravel and shake out the cardboard roll traps. The height is designed so individuals can work at a comfortable level while standing. The height of the hopper also facilitates a steep descent of the termites to the sieves below, without being so high as to cause termite injury. The removable screen facilitates dumping of debris and occasional cleaning of the hopper. This device was made to order within a week's time by a University of Toronto sheet metal fabricator for about $300.00 Cdn., including parts and labor.

The baffle separator is inexpensive and simple to construct from materials available at office and art supply stores. Construction of the baffle separator requires an hour or so of measuring, drawing lines, folding, punching holes, inserting dowels and stapling the reinforcement strips. The ease with which these devices are constructed improves with practice. These devices are fairly sturdy and can be used daily for several months before getting too dirty and worn. They have been used successfully in the lab and in the field for rapidly removing large numbers of termites from soil and nest debris.

The tray-in-box separator can be readily made from any combination of trays that fit in boxes. A suitable combination of trays and boxes are the standard plastic or fibreglass cafeteria trays and matching busboy boxes that can be purchased at restaurant supply companies at modest costs. Such boxes also have the advantage of being sturdy and having ridges that facilitate the space-saving, stable stacking arrangement (Fig. 4).

Experimental Assessment of Efficiency of Baffle Separator

Extractions of termites by the end of the first three-minute interval ranged from 39.8 to 86.5% (Table I). By the end of the second three-minute interval, extraction ranged from 8.3 to 30.6%. By the end of third three-minute interval, extraction ranged from 2.2 to 14.8%. By the end of the fourth three-minute interval, the additional percentage of termites extracted was below 10% in all cases. The average extracted at the end of three minutes was 56.8%, the cumulative average at six

TABLE I. Percentage of termites extracted from soil at three-minute intervals using baffle extractors from fourteen sites in Toronto, Ontario, Canada.

		3-minute intervals					
	Site	1	2	3	4	5	remainder
1	Blake 1	50.0	23.0	10.2	5.7	3.6	7.5
2	Blake 2	46.8	27.3	10.0	6.0	3.6	6.3
3	Blake 3	39.8	22.9	14.8	5.6	4.6	12.3
4	Borden	64.6	21.7	7.9	2.9	1.4	1.5
5	First	53.4	23.4	12.6	4.6	2.8	3.2
6	Fontainbleau	52.9	30.6	9.0	2.7	1.3	3.5
7	Gough 1	46.1	27.3	10.0	7.2	4.9	4.5
8	Gough 2	53.9	26.3	8.9	4.5	2.0	4.4
9	Logan	84.7	9.5	2.3	1.9	0.4	1.2
10	Montrose	86.5	8.3	2.2	1.2	0.5	1.3
11	Mould 1	45.9	25.9	13.2	6.7	3.7	4.6
12	Mould 2	47.3	17.9	12.0	7.9	5.5	9.4
13	Pritchard	53.5	24.4	8.6	5.5	3.3	4.7
14	Riverdale	69.8	15.5	8.1	3.5	1.4	1.7
Average		56.9	21.9	9.5	5.0	3.1	4.7
Cumulative Average		56.8	78.7	88.2	93.2	96.4	100.0

minutes was 78.7%, at nine minutes was 88.2%, at 12 minutes was 93.2% and at 15 minutes was 96.4%.

Discussion

Although numerous researchers have developed and refined various procedures and devices for trapping and baiting subterranean termites, few have examined how to efficiently extract large numbers of debris-free termites from their native substrate. The methods still widely used are labour intensive and time consuming. For example, the American Society for Testing and Materials, Standard D3345 (ASTM 1999), involves a standard technique termed “papering-off” (Gay et al. 1955). While this method has proved adequate for obtaining the few thousands of termites needed for typical bioassay tests, it is a slow, low-yield process. Tamashiro et al. (1973) proposed an extraction method in which termites were transferred from a tray with trap substrate to a tray with clean wood by migrating along damp wooden tongue depressors placed like bridges between the trays. Although this method has been used successfully for years, it is somewhat slow and requires the tedious process of setting up bridges. A further drawback of this method is that if a large amount of material is being processed, then a large amount of bench or floor space is needed.

With the start of Trap-Treat-Release field trials in Toronto in 1993, various methods were used in an attempt to separate collected termites from their substrate. These methods included “papering off”, pump aspiration, paper and wood bridging mechanisms, and manual separation of termites from soil by placing them on an inclined tray and brushing them off the lower rim with a soft-hair paintbrush. Such methods required much time and tedious effort. In the first year of trials, the separation process was the rate-limiting step in the Trap-Treat-Release process. The three extraction devices that have been developed have significantly reduced the amount of time and effort spent in the separation process. Furthermore, these methods generate debris-free termites, permitting precise gravimetric quantification of the termites collected. Since the termites are completely separated from the soil it is a simple matter to weigh them, and, based on the weight of a counted sub-sample, determine the number of termites collected. This permits actual numbers of trapped termites to be recorded, which is simpler than inferring termite levels by calculating bait consumption (Su et al. 1993). In addition to rapidly separating large numbers of termites from their substrates, the extraction devices are simple to make and economical. Over 25 million termites have been processed by these methods since 1993.

More rapid and effective trapping, extraction and quantification of large numbers of live termites opens up many new possibilities for research, control, and ecological management using termites. For example, although baiting with toxic baits does not require trapping termites, it might be found that baiting could be promoted by trapping large numbers and then feeding them under no-choice feeding conditions for a day or more on baits before releasing them. Under such no-choice bait-feeding conditions, the trapped population could be made to consume larger amounts of bait and probably higher concentrations of bait toxicant. Such an approach remains to be tested.

More importantly, potential beneficial uses of termites can be explored. Termites possess unique digestive and nitrogen-fixing capabilities that are rare in animals (Martin 1991; Slaytor and Chappel 1994; Waller 2000; Lilburn et al. 2001). Termites can digest all classes of plant polymers including cellulose, hemicellulose and lignin, converting these otherwise indigestible, highly-abundant, renewable sources of organic carbon into animal protein, through the aid of symbiotic hindgut protozoans and bacteria (Abe and Higashi 1991; Kato et al. 1998). Thus, termites constitute a major ecological conduit through which plant cell wall polymers are converted into animal biomass (Higashi et al. 1992; Higashi and Abe 1996). Insectivores, which comprise large assemblages of some of the world's most diverse groups, including most reptiles, amphibians, birds and many mammals such as the edentates, pangolins, aardvarks, etc., utilize termites as an abundant and nutritious food-source (Redford and Dorea 1984). Furthermore, termites make up a significant portion of the diet in some human cultures in the tropics (Dufour 1987; Logan 1992). Through the bioconversion of lignocellulosic plant polymers to animal protein, and as superabundant prey items, termites aid in the maintenance of biodiversity. Termites function as keystone species in most tropical ecosystems in the degradation of cellulosic and humic matter, and in the pedoturbation of soils (Higashi and Abe 1996; Lavelle et al. 1997).

With their unique ability to convert plant fiber to animal biomass (lipids and proteins), and with their abundance in social colonies, termites can be exploited for agricultural purposes. Abasiekong (1997) describes termites being cultured on fibrous agricultural residues, which are then ground into animal feed with resulting greater protein content and reduced fiber content. Termite alates (winged forms) have been used as a source of feed for poultry and fish production in tropical countries (Logan 1992). In addition, termites can be used to decompose agricultural residues and, in the process, aid in revitalizing soil through increased nitrogen fixation. Termite tunneling also promotes soil aeration and water infiltration. In addition to agricultural uses, it might be possible to apply termites' unique digestive capabilities to manage urban wood and paper wastes.

The methods described here provide low-cost, low-tech tools which promote greater utilization of termites and termite biomass. For example, they could be used by small farmers in rural tropical areas for small-scale harvesting of termites as animal feed. Large numbers of collected termites could be used to assist in conservation projects for endangered termitivores such as the Australian echidna and numbat. Collected termites could be used as feed for certain termitivorous zoo animals or pets such as dendrobatid frogs.

In order for termites to be productively utilized (termiticulture, termite composting, environmental rehabilitation, conservation management, etc.), it will be necessary to have tools and procedures which permit the efficient harvesting, handling, and processing of termites from either natural or cultivated substrates. The devices discussed here may help to promote beneficial uses of an order of insects which have historically been viewed only as pests

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INTEGRATED PEST MANAGEMENT OPTIONS FOR THE CONTROL OF *ACALYMMA VITTATUM* (FABRICIUS), THE STRIPED CUCUMBER BEETLE IN SOUTHWESTERN ONTARIO

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Abstract

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In response to increased grower concerns, research was undertaken to investigate field biology, insecticide resistance and integrated management of striped cucumber beetle (SCB), *Acalymma vittatum* (F.), the most important insect pest of Cucurbitaceae in Ontario. Mini-Masner and baited yellow sticky traps revealed that, in southwestern Ontario, SCB are univoltine, overwintered adults entering cucurbit fields as plants emerge or are transplanted. Field studies found that foliar application of currently recommended azinphosmethyl or endosulfan effectively protected cucurbit foliage for only four days. Laboratory bioassays identified acetamiprid, imidacloprid, thiamethoxam, carbaryl, and cypermethrin as potentially effective alternative insecticides for SCB control. Application of imidacloprid as a planting water or seed treatment respectively protected developing seedlings for as long as four and five weeks. Trap rows of squash grown from seed treated with imidacloprid did not provide consistent protection of cucumber seedlings. Planting water and, especially seed treatments for SCB control in cucurbits could realize significant economic and environmental benefits for Ontario growers. A sustainable integrated SCB management strategy for Ontario cucurbit growers is outlined.

Introduction

Recently, production of Cucurbitaceae (cucumbers, gherkins, pumpkins, squash and melons) in southwestern Ontario has more than doubled, rising from 2,515 ha in 1995 to 5,075 ha in 2000 (Anonymous 2000). Correspondingly, farm value of produce harvested rose by nearly 25% from $19.5 million (Cdn $) in 1995 to $24.3 million (Cdn $) in 1999 (Anonymous 2000). First reported in North America in the mid-19th century (Harris 1842), the striped cucumber beetle (SCB), *Acalymma vittatum* (F.), is considered the most important insect pest of Cucurbitaceae across the United States and southern Canada (Hoffmann et al. 1996). Adults feed on the cotyledons, leaves, flowers, and fruit, while the larvae are strictly root feeders (Matthewman 1951). Economic losses result from both direct feeding and the transmission of *Erwinia tracheiphila* (E.F. Smith) Holland, the bacteria responsible for bacterial wilt. If control measures are not implemented, Canadian yield losses due to direct feeding by SCB and the related spotted cucumber beetle, *Diabrotica undecimpunctata howardi* (Barber), have been estimated at 15%. Losses due to bacterial wilt can further reduce yields (Pitblado and Lucy 1994).

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Although SCB economic thresholds for cantaloupe and pickling cucumbers have been determined in the United States (Brust and Foster 1999), neither decision-making strategies nor integrated pest management (IPM) programs are presently practised in Ontario. While biology, seasonal density, behaviour and damage have been well documented for SCB in the United States (Lewis et al. 1990), laboratory and field studies on Canadian population dynamics and seasonality have not been published. Indeed, no Canadian work has been reported since Matthewman summarized SCB biology and control in 1951.

For a number of years, Ontario cucurbit growers have expressed concern about unsatisfactory SCB control in their fields. By 1997, this concern had increased to the point where "identification of insecticide resistance in cucumber beetle populations on cucurbits" was identified as a specific research priority by the Ontario Fruit and Vegetable Growers' Association. In response, research began in 1998 to improve management programs in Ontario fields. This paper summarizes subsequent observations on Ontario SCB field biology; compares efficacy and economics of current and experimental chemical SCB control tactics and, finally, recommends an integrated SCB control strategy for Ontario growers.

Materials and Methods

Field Biology

Adult SCB were monitored using: 1) modified mini-Masner (MM) traps (Masner and Goulet 1981; MacIntyre 2000) and, 2) yellow sticky traps baited with a synthetic cucurbit blossom kairomone (1:1:1 mixture of 1,2,4-trimethoxybenzene, indole, and *trans*-cinnamaldehyde [TIC])(Hoffman et al. 1996). In 1998 only, a single MM trap was located in the border row of a block of squash in Talbotville, Ontario. Insects were collected and identified weekly from June until September. Four yellow sticky traps, separated by 10 m, were located in a line in the border row of a large block of cucurbits on the same farm. Insects were counted weekly from mid-July until September in 1998 and from June until September in 1999; all traps and baits were changed when insects were counted. Trap height was adjusted each week to position traps 15–30 cm above the developing plant canopy. Data collected were used to establish seasonal SCB population trends.

Management

Chemical Control: In order to identify insecticides more toxic to SCB than currently recommended endosulfan, a culture was established from SCB collected near Talbotville, ON in September 1998 and subsequently continuously reared in the laboratory following a protocol modified from Cuthbert et al. (1968). Adults, maintained in mesh cages in walk-in insectaries (25 ± 1°C; 65 ± 5% RH; 16 L:8 D) at Southern Crop Protection and Food Research Centre (SCPFRC) London, were fed cucumber or squash seedlings, pollen and water *ad libitum*; larvae were reared on squash or cucumber seedlings (MacIntyre 2000). Seven insecticides were compared by direct-contact bioassay: 1. endosulfan (97.9% purity); 2. carbaryl (99.9%); 3. fipronil (97.1%); 4. acetamiprid (99.9%) (1–4, Aventis CropScience Canada, Regina, SK); 5. imidacloprid (97.1%) (Bayer Inc. Agriculture Division, Crop Protection, Toronto, ON); 6. cypermethrin (91.1%); and, 7. thiamethoxam (97.1%) (6–7, Syngenta Crop Protection, Guelph, ON). Groups of 10 adults were anaesthetized with CO_2 in clean, waxed pasteboard cups. Anaesthetized SCB were transferred to glass petri dishes and placed in the Potter spray tower. Five ml aliquots of the desired concentration of each technical grade insecticide solution in acetone-olive oil (Harris and Turnbull 1986) were sprayed onto beetles. Treated SCB were transferred into clean pasteboard cups containing a dental wick dipped in reverse osmosis water. A glass petri dish prevented escape. At least three bioassays were performed for each concentration of each insecticide. Bioassays were held at 27 ± 1°C and 65 ± 5% RH under continuous light. Control insects treated with only acetone-olive oil were included in each test. Mortality was counted after 24 hrs; data were corrected for natural mortality (<15 % for all bioassays) using Abbott's correction (Abbott 1925). Regression lines, LC_{50} and 95% Fieller limits for each insecticide were calculated using a log-probit analysis program (S103, Statistical Research Service, Agriculture and Agri-Food Canada).

Experiments were also undertaken to evaluate performance of recommended and experimental insecticides for SCB control under field conditions (MacIntyre-Allen et al. 2001).

Cultural Control: In addition to pest monitoring and chemical control, an SCB-IPM program may include cultural management. Radin and Drummond (1994) found that squash was an effective trap crop for cucumber. Expanding on their work, protection of pickling cucumbers by squash trap crops grown from either untreated or imidacloprid-treated seed was investigated at two sites (Lot 17, Concession 3 and Lot 3, Concession 9, Township of Delhi, R.M. Haldimand-Norfolk) in each of 2000 and 2001. At each site, a single trap row of squash seedlings (cv. Mini-Green Hubbard) was planted as the outside row of the experimental field. The trap row was divided into 25 m lengths. Three treatments were evaluated: Blank (no squash seedlings); Untreated (no seed treatment applied to squash seed); Treated (squash seed treated with imidacloprid [GAUCHO® 480F] @ 5.0 mg a.i./seed). At each site each year, all treatments were replicated down the row, at least three times, in a randomized complete block design. At regular intervals after planting the trap row, SCB feeding damage was counted in cucumber seedlings in the row adjacent to the trap row (Row 1) and in the fifth row from the trap row (Row 5). In each plot, SCB damage was evaluated in two sub-samples, separated by 3 m. The first sampled plant was located approximately 5 m from either end of the plot; damage was then counted in the next 20 (2000) or 15 (2001) plants in succession. The number of feeding scars was counted in each cotyledon and, as growth continued, in the 3–5 youngest true leaves on each plant. Damage was expressed as the number of feeding holes/cotyledon or leaf. Significance of observed differences in feeding damage among treatments in each cucumber row on each sampling date was estimated by Analysis of Variance and Fisher's Protected Least Significant Difference test (Statistix Analytical Software, Tallahassee Florida).

Benefit Analysis

To determine the relative costs of different methods of SCB management in cucumbers and squash, data on recommended planting densities were determined from the 2000–2001 Vegetable Production Recommendations (OMAFRA 2000). Grower costs of formulated insecticides were obtained either from Pesticides for Fruits, Vegetables and Field Crops in Ontario (Goodwin 2000) or directly from the manufacturer (Gustafson Partnership, Calgary AB). Labour costs for pesticide application were derived from the annual provincial summary of custom work rates (Anonymous 2002). To permit direct financial comparison, costs for each program were then calculated and expressed in terms of dollars/ha.

Results and Discussion

Field Biology

Mini-Masner traps effectively collected SCB for only the first three weeks of plant development. As rampant vine growth obscured the collecting screen, SCB collection efficiency decreased; for this reason MM traps were not installed in 1999 (Fig. 1). Baited sticky traps, however, remained effective throughout the entire season. The use of baited sticky traps would provide a relatively simple, fast and affordable method for growers to monitor SCB populations in their fields.

Our studies showed that in Ontario SCB are univoltine. Overwintered adults arrived *en masse,* in cucurbit fields the third week of June in both 1998 and 1999 (Fig. 1). SCB fed on available cotyledons and first true leaves; distribution throughout cucurbit fields was patchy with highest

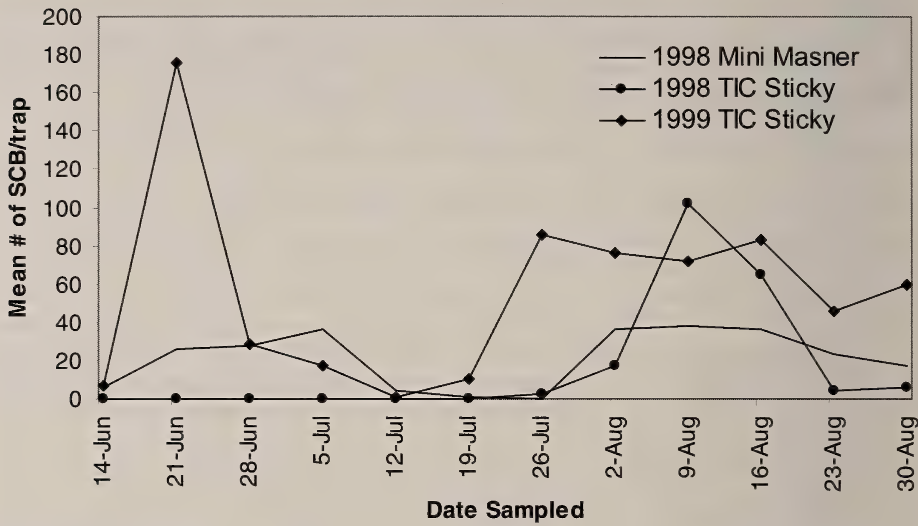

FIGURE 1. Mean number of striped cucumber beetles per Mini Masner and TIC baited sticky traps setup in squash fields in Talbotville, Ontario from June until September in1998 and 1999.

populations generally along field edges. Similar to observations by Pair (1997), the most severe damage observed occurred early in the season when plants ranged from the cotyledon to the 5th true leaf stage in both 1998 and 1999. Adult numbers decreased the last week of June with the death of overwintered adults. In the last week of July, populations increased as first generation adults began to emerge and feed on flowers and developing fruit (Fig. 1). Late season damage was not economically important in our trials.

SCB can also be directly counted on the developing vines. In the United States economic thresholds (ET) and economic injury levels (EIL) have been developed for cucumbers and muskmelons. While Burkness (1996) reported an EIL of 0.1–7.0 SCB per plant for processing cucumbers, equivalent to an ET ranging from 0.1–5.0 (75 % of EIL) SCB per plant, Brust and Foster (1999) proposed an ET of 0.5–1.0 SCB per plant for muskmelon. Although no similar work has been done in Canada, Ontario cucurbit growers could adopt these ET and EIL. To date, no EIL have been determined for either squash or pumpkin.

Management

Chemical Control: The next phase in the development of an effective IPM program is to examine different control tactics. At present, cucurbit growers in southern Ontario almost exclusively rely on foliar applications of endosulfan (THIODAN®) or azinphosmethyl (GUTHION®) to control SCB. Current Vegetable Production Recommendations indicate that growers should begin to spray when seedlings are breaking through the soil and repeat application when beetles reappear throughout the season (OMAFRA 2000). With only two chemicals available, insecticide resistance has become a concern.

Although direct contact bioassay studies in the laboratory did not identify resistance to either endosulfan or azinphosmethyl in any of 11 SCB populations sampled across southwestern Ontario, one population was identified with higher tolerance to both chemicals (MacIntyre 2000). While SCB tolerance to these two chemicals was evaluated in the laboratory, field studies of persistence

TABLE I. Relative toxicity of insecticides to laboratory-reared adult striped cucumber beetle, *Acalymma vittatum* treated in a Potter spray tower.

Insecticide	n[1]	Slope ± SEM	LC_{50}[2]	95% F.L.[3]	Relative Toxicity[4]
endosulfan	156	2.0 ± 0.4	556.0	500.0 – 762.0	1
thiamethoxam	170	2.0 ± 0.5	8.0	2.0 – 9.0	69
cypermethrin	200	2.0 ± 0.6	8.0	0.2 – 9.0	73
carbaryl	160	3.0 ± 0.6	5.0	0.0 – 6.0	102
fipronil	150	2.0 ± 0.5	2.0	0.1 – 3.0	251
imidacloprid	319	1.0 ± 0.6	1.0	0.1 – 4.0	400
acetamiprid	160	2.0 ± 0.4	0.3	0.0 – 3.0	1794

[1] number of SCB tested

[2] concentration (ppm)

[3] Fieller limits

[4] calculated by dividing the observed LC_{50} for endosulfan by the observed LC_{50} for the test insecticide

on vine foliage demonstrated that both endosulfan and azinphosmethyl effectively protected foliage for less than four days (MacIntyre-Allen et al. 2001). These observations had two major implications:

1) Growers applying either insecticide early in the season, as beetles began arriving from overwintering sites, would realize effective control for only a few days after the initial spray application. This lack of long-term control might explain why growers felt SCB were becoming resistant to both endosulfan and azinphosmethyl.
2) One application of either endosulfan or azinphosmethyl would not have adequately controlled SCB populations in either 1998 or 1999. Additional weekly sprays would have been required until plants became established.

Application of weekly sprays of only two chemicals contradicts a basic principle of both IPM and Integrated Resistance Management. While endosulfan and azinphosmethyl do have different modes of action, their relatively short residual activity dictated repeated application. Inclusion of other insecticides with different modes of action would therefore strengthen the control program. The two most promising experimental insecticides identified were acetamiprid and imidacloprid, respectively, 1794 times and 400 times more toxic than endosulfan (Table I). Fipronil, carbaryl, cypermethrin and thiamethoxam were also more toxic than endosulfan. Carbaryl, however, is currently under review in the USA as dictated by the Food Quality and Protection Act (1996); future Ontario recommendation for SCB management is therefore unlikely. Chloronicotinyl (acetamiprid, imidacloprid), pyrethroid (cypermethrin) and phenylpyrazole (fipronil) insecticides were all effective SCB control agents. Addition of these insecticides to the current arsenal would strengthen the current SCB management program and would help to slow the development of insecticide resistance.

The method of insecticide application can have a pronounced impact on duration of plant protection. For example, while imidacloprid and cypermethrin were quite toxic to SCB in the laboratory, foliar application of these insecticides did not provide more than four days' protection under field conditions (MacIntyre-Allen et al. 2001). Planting water and seed treatments of imidacloprid proved more persistent than foliar application. Planting water application of 6.0 mg a.i./plant protected seedlings for up to four weeks after planting. Seed treatment protected cucumber

TABLE II. Effect of squash-trap rows on damage to pickling cucumbers by striped cucumber beetle (SCB), *Acalymma vittatum*, in southwestern Ontario, 2000–2001.

		Mean Number SCB Feeding Holes/Leaf[1] for Indicated Site and Treatment[2]							
		Site 1				Site 2			
Row Counted[3]	Days after Planting[4]	Stage[5]	Blank	Untreated	Treated	Stage	Blank	Untreated	Treated
a) 2000:									
1	14	C	0.7 b[6]	2.2 a	0.4 b	C	0.3 b	0.6 a	0.2 b
5			0.2 b	0.4 a	0.1 b		0.6 a	0.6 a	0.2 a
1	21	1 TL	1.0 b	2.4 a	0.1 c	1 TL	0.6 b	1.2 a	0.6 b
5			0.3 a	0.4 a	0.3 a	C	2.1 b	3.8 a	1.6 b
1	28	3 TL	8.5 a	6.3 b	6.0 b	3 TL	0.8 a	1.1 a	1.1 a
5			2.8 a	2.4 a	1.9 a	5 TL	1.7 a	2.1 a	1.4 a
b) 2001:									
1	10	C	0.1 b	0.3 a	0.0 b	C	4.9 a	2.3 a	3.1 a
5			---[7]	---	---		---	---	---
1	17	2 TL	0.6 a	0.8 a	0.7 a	3 TL	6.7 a	4.3 a	5.6 a
5			0.8 a	0.0 a	1.0 a		2.3 a	2.9 a	2.3 a
1	24	4 TL	6.2 a	4.6 a	5.1 a	5 TL	10.2 a	9.3 a	10.8 a
5			4.8 a	1.7 a	4.4 a		5.0 a	5.0 a	5.2 a

[1] Based on counts of damage to 2 × 20 (2000) or 2 × 15 (2001) cotyledons or youngest true leaves (maximum 4) per plot on each sampling date. A minimum of three replicates of each treatment was established at each site each year.

[2] Blank: no squash plants in trap row; Untreated: squash grown from untreated seed; Treated: squash grown from seed treated with 5.0 mg a.i./seed imidacloprid.

[3] Relative to trap row; Row 1 located adjacent to trap row; Row 5 was fifth row from trap row.

[4] Days after planting trap row.

[5] Cucumber growth stage when SCB damage assessed (C: cotyledon; TL: true leaf/leaves).

[6] On each sampling date, values within a row for each site followed by the same letter are not significantly different as determined by ANOVA and Fisher's Protected LSD test.

[7] Data not available.

seedlings for six and a half weeks when applied at 0.75 mg a.i. plant and squash seedlings for nearly three weeks when applied at 1.0 mg a.i./plant (MacIntyre-Allen et al. 2001).

Cultural Control: Preliminary results in 2000 indicated that in the first three weeks after planting, cucumber plants in the row immediately adjacent to the imidacloprid-treated squash plants had significantly less feeding damage than cucumber plants beside untreated squash plants (Table IIa). In the same time period, cucumbers beside blank lengths of the trap row had less damage than cucumbers beside untreated squash plants. Data collected from cucumbers five rows from the trap row were not as consistent. In site 1, 14 days and in site 2, 21 days after planting feeding damage was higher for cucumbers parallel to untreated squash compared to those parallel to treated squash (Table IIa).

Results were less promising in 2001 (Table IIb). SCB feeding damage was significantly reduced adjacent to treated squash plants only at site 1 and 10 days after planting. In both years however, SCB populations and consequent damage were generally quite low in the experimental fields. More work is needed to examine the potential benefits of trap rows under heavier adult pressure.

IPM also encourages the use of biological agents for control of pest populations. However, it is unlikely that under Ontario conditions insect biological agents would have a significant impact on SCB. Most cucurbits are short-term crops; pickling cucumbers, for example, grow from seed to harvest in as little as 51 days. Although a number of parasitoids including *Celatoria setosa* (Coq.) (Diptera: Tachinidae) and *Syrrhizus diabroticae* (Gahan)(Hymenoptera: Braconidae) can moderate SCB numbers, population densities of the parasitoids are generally too low in the early season to effectively prevent damage (Gould 1944). While we did identify low populations of *C. setosa* late in the season, no work was undertaken to identify conditions that would favour field populations of these agents. Neither of these biological agents are commercially available.

Benefit Analysis

Depending on the insecticide selected and the number of applications required, the cost of the current foliar SCB management program for cucumber ranges from approximately $103.00–$128.00/ha (Cdn $) (Table III). Costs would increase if extended arrival of the over-wintered population (Fig. 1) required application of an additional insecticide and would decrease if only a single flush of SCB was recorded. Registration and application of cypermethrin and imidacloprid for foliar application would greatly reduce selection pressure without increasing the number of treatments; depending on the replacement insecticide, the cost of foliar SCB management could either increase marginally or decrease substantially (Table III).

Cucumber seed treatment might be an effective method for SCB management. Seed treatment was less costly (Table III) and protected developing seedlings significantly longer than any foliar application (MacIntyre-Allen et al. 2001). Cucumber seeding densities vary widely, depending on the end use of the crop. Final plant densities range from a high of 150,000 plants/ha for machine-harvested, pickling cucumbers, down to 20,600 plants/ha for hand-picked, slicing cucumbers. At the highest seeding density, the cost of seed treatment is competitive with the cheapest foliar control program (Table III). At lower seeding densities, the potential economic advantage of seed treatment is quite significant.

Planting water treatments also showed promise for SCB management in slicing cucumbers. A few growers seeking premium prices for early cucumbers, plant plug seedlings each year. We did not evaluate planting water treatments for cucumbers in our work. However, at lower planting densities, even if the 6.0 mg a.i./plant rate found effective in squash (MacIntyre-Allen et al. 2001) was applied to cucumber transplants, the cost of planting water treatment compares favourably with the current cost of foliar SCB control (Table III).

Costs of foliar protection against SCB for squash and pumpkin are the same as for cucumber (Table IV). Early in the season it may be possible to reduce product costs by as much as 60% if the

TABLE III. Relative costs of cucumber management programs for early season control of striped cucumber beetle, *Acalymma vittatum*, in south-western Ontario.

Cucumber Type	Pickling	Pickling	Pickling	Pickling	Pickling	Slicing	Slicing
Common Name	endosulfan	azinphosmethyl	cypermethrin	imidacloprid	imidacloprid	imidacloprid	imidacloprid
Trade Name	THIODAN® 4EC	GUTHION® 240SC	RIPCORD® 400EC	ADMIRE® 240F	GAUCHO® 480F	ADMIRE® 240F	GAUCHO® 480F
Unit Cost/L	$15.15	$14.00	$114.25	$246.85	$500.00	$246.85	$500.00
Application Method	foliar	foliar	foliar	foliar	seed treatment	planting water	seed treatment
# Applications	3	2	2	2	1	1	1
Rate Applied/ha	1.5 L	2.25 L	87.5 ml	0.2 L	85.4–260.0 ml[1]	465.0–695.0 ml[2]	32.0–48.0 ml[3]
Material Cost/ ha/Application	$22.73	$31.50	$10.00	$49.37	$42.70–$130.00	$114.79–$171.56	$16.00–$24.00
Labour Cost/ ha/Application	$20.00[4]	$20.00[4]	$20.00[4]	$20.00[4]	$0.00[5]	$0.00[6]	$0.00[5]
Total Cost/ ha/Application	$42.73	$51.50	$30.00	$69.37	$42.70–$130.00	$114.79–$171.56	$16.00–$24.00
Total Cost/ha for Program	$128.19	$103.00	$60.00	$138.74	$42.70–$130.00	$114.79–$171.56	$16.00–$24.00

[1] based on application rate of 0.75 mg a.i./seed to 55.0–167.0 × 10^3 seeds/ha, and assumes germination of 90% to give a final plant population of 50.0 (hand-pick)–50.0 (machine harvest) × 10^3 plants/ha (OMAFRA 2000)

[2] based on application of 6.0 mg a.i./plant to plant population of 20.6–30.9 × 10^3 plants/ha (OMAFRA 2000)

[3] based on application rate of 0.75 mg a.i./seed to 20.6–30.9 × 10^3 seeds/ha, and assumes germination of 90% to give a final plant population of 18.5–27.8 × 10^3 plants/ha (OMAFRA 2000)

[4] Anonymous 2002

[5] no additional charge for application as commercial seed-treaters include cost of application in the cost of the seed-treatment formulation. Small scale growers might have to consider cost of their own time should they treat seed on-farm.

[6] no additional charge for application as growers would add ADMIRE to starter solution (water ± starter fertilizer) which is deposited with each transplanted seedling

TABLE IV. Relative costs of squash/pumpkin management programs for early season control of striped cucumber beetle, *Acalymma vittatum*, in southwestern Ontario.

Common Name	endosulfan	azinphosmethyl	cypermethrin	imidacloprid	imidacloprid	imidacloprid
Trade Name	THIODAN® 4EC	GUTHION® 240SC	RIPCORD® 400EC	ADMIRE® 240F	ADMIRE® 240F	GAUCHO® 480F
Unit Cost/L	$15.15	$14.00	$114.25	$246.85	$246.85	$500.00
Application Method	foliar	foliar	foliar	foliar	planting water	seed treatment
# Applications	3	2	2	2	1	1
Rate Applied/ha	1.5 L	2.25 L	87.5 ml	0.2 L	83.3–154.2 ml[1]	38.5–71.9 ml[2]
Material Cost/ ha/Application	$22.73	$31.50	$10.00	$49.37	$20.56–$38.06	$19.25–$35.95
Labour Cost/ ha/Application	$20.00[3]	$20.00[3]	$20.00[3]	$20.00[3]	$0.00[4]	$0.00[5]
Total Cost/ ha/Application	$42.73	$51.50	$30.00	$69.37	$20.56–$38.06	$19.25–$35.95
Total Cost/ha for Program	$128.19	$103.00	$60.00	$138.74	$20.56–$38.06	$19.25–$35.95

[1] based on application of 6.0 mg a.i./plant to plant population of $3.3–6.2 \times 10^3$ plants/ha (OMAFRA 2000)

[2] based on application rate of 5.0 mg a.i./seed to $3.7–6.9 \times 10^3$ seeds/ha, and assumes germination of 90% to give a final plant population of $3.3–6.2 \times 10^3$ plants/ha (OMAFRA 2000)

[3] Anonymous 2002

[4] no additional cost for application as growers would add ADMIRE to starter solution (water ± starter fertilizer) which is deposited with each transplanted seedling

[5] no additional cost for application as commercial seed-treaters include cost of application in the cost of the seed-treatment formulation. Small scale growers might have to consider cost of their own time should they treat seed on-farm.

grower applies the insecticide only in a band over small seedlings (OMAFRA 2000). Product cost ranges from approximately 53%–61% of the total cost of foliar application. Since plant populations of both squash and pumpkins are generally much lower than those for cucumber, transplanted seedlings of these crops are much more common. Planting water protection of those transplants is an attractive option; protection is more persistent (MacIntyre-Allen et al. 2001) and cost is much lower (Table IV). The benefits of seed treatment for protection of squash and pumpkin are slightly greater than planting water treatments (Table IV).

The benefits of planting water and, especially seed treatments for SCB control in cucurbits are more than economical. For example, such treatments may have less impact on beneficial insects. In contrast with non-systemic insecticides such as endosulfan and azinphosmethyl, application of a systemic insecticide such as imidacloprid is felt to be relatively safe for beneficial insects that do not feed directly on the treated plant (Pflüger and Schmuck 1991). Sublethal effects on a predator such as *Harmonia axyridis* (Pallas) and a parasitoid such as *Microplitis croceipes* Cresson have, however, been reported (Stapel et al. 2000; Vincent et al. 2000). Predators and parasitoids, however, are unlikely to play a significant role in SCB regulation early in the season (Gould 1944). Safety to pollinating insects such as introduced honeybees, *Apis mellifera* L. is also a concern. Recent comprehensive studies have, however, clearly shown that treatment of sunflower seed with imidacloprid posed no risk to honeybees (Schmuck et al. 2001).

Additional benefits of seed treatment include: reduced operator exposure; reduced soil erosion and compaction; and, a significantly reduced quantity of insecticide required for effective SCB control. For example, pumpkin seed treatment could require as little as 18.5 g a.i. imidacloprid/ha. Equivalent protection by foliar treatment would require at least two applications of imidacloprid ($48 \times 2 = 96$ g a.i./ha) or endosulfan ($600 \times 2 = 1{,}200$ g a.i./ha). The consequent environmental benefit ranges from 80.7% for imidacloprid to as high as 98.5% were endosulfan applied to developing seedlings.

Conclusion

Current production recommendations in Ontario suggest that cucurbit growers spray when seedlings are breaking through the soil and repeat application if SCB adults reappear (OMAFRA 2000). Our research demonstrated that cucurbit growers should begin to monitor fields with TIC-baited sticky traps at the time of seeding or transplanting. When SCB appear on traps, growers should begin to check cucumber and melon plants and apply azinphosmethyl or endosulfan at recommended rates when the population reaches the ET. As mentioned earlier, no ET have been established for squash and pumpkin; it is, however, unlikely that EIL for these crops would be lower than those for cucumber.

Although early season control is the main concern in Ontario, monitoring with TIC-baited sticky traps should continue throughout the season. If the first generation population increases above the ET, growers should rotate to azinphosmethyl or endosulfan depending on which insecticide was used for control of overwintered SCB. To further delay development of resistance to foliar insecticides, we recommend that current labels for cypermethrin and imidacloprid, insecticides with different modes of action, be expanded to include SCB control. Both insecticides provided short-term protection when applied to foliage.

Our research further indicated that imidacloprid, as a planting water treatment and, especially as a seed treatment, is an excellent alternative to foliar application of endosulfan or azinphosmethyl. We recommend extension of current Canadian labels for both ADMIRE® 240F (planting water treatment) and GAUCHO® 480FL (seed treatment) to include SCB control. Label extension would allow Ontario growers to avail themselves of the significant economic and environmental benefits of these applications and would further benefit the expanding Ontario cucurbit industry.

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DIVERSITY AND CONSERVATION STATUS OF PRAIRIE ENDEMIC AUCHENORRHYNCHA (HOMOPTERA) IN ALVARS OF THE GREAT LAKES REGION

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Abstract

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Eighteen species of prairie endemic Auchenorrhyncha (Homoptera) representing three families: Cicadellidae (16 species); Caliscelidae (1); and Delphacidae (1), were recorded from alvar habitats in the Great Lakes region. The three alvar regions with the highest number of prairie endemic species were Northern Michigan (USA), Bruce Peninsula (Ontario) and Manitoulin and surrounding islands (Ontario). Numbers of species of prairie endemic Auchenorrhyncha varied from one alvar region to another and between sites within each region. Five species: *Aflexia rubranura* (DeLong); *Memnonia panzeri* Hamilton; *Mocuellus americanus* Emeljanov; *Texananus marmor* (Sanders and DeLong); and *Caenodelphax nigriscutellata* (Beamer) **comb. n.**, were restricted to alvar habitats in the study area. Our data indicate that Auchenorrhyncha species are useful as indicators of alvar quality for conservation and management purposes.

Introduction

Alvars are prairie-like communities that occur on flat limestone bedrock primarily in the Great Lakes region of North America and the Baltic Sea region of Europe (Catling and Brownell 1995; Rosén 1995). Most North American alvars are in southern Ontario with others in Quebec, Michigan, New York, Ohio, Vermont and Wisconsin (Catling and Brownell 1995; Bouchard 1997) and exist currently as isolated, open "islands" surrounded by forested areas. Alvars are characterized by a thin layer of soil and annual extremes in moisture and temperature and are dominated by grasses, sedges and shrubs (Catling and Brownell 1995). Many factors including periodic summer droughts, seasonal flooding in spring and fall, frost upheaval, lack of soil and grazing by large mammals are thought to have played a major role in restricting the growth of woody vegetation in alvars (Petterson 1965; Stephenson and Herendeen 1986; Rosén 1995). Trees, when present, are often confined to deeper and wider cracks in the bedrock where soil has accumulated.

The presence of rare, endemic and restricted plant species in Great Lakes alvars has been well documented and the need to protect this habitat has received much attention recently (e.g., Belcher and Keddy 1992; Catling and Brownell 1995; Reschke et al. 1999; Brownell and Riley 2000). Several alvars have already been damaged or destroyed by limestone quarrying, housing development, coal dumping, heavy grazing and other factors (Hamilton 1990; Catling and Brownell

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1995). The extensive data on vascular plants have been useful in identifying high quality alvar sites for conservation and management; comparable data on animal taxa are scarce.

Leafhoppers and allies (Homoptera: Auchenorrhyncha) are one of the most abundant and characteristic animal groups in open, grassy areas of temperate regions (Morris 1971; Waloff and Solomon 1973). Several species of Auchenorrhyncha occur on a single host plant or a few closely related species in a genus and, therefore, have been considered useful indicators of grassland quality for conservation purposes (Whitcomb 1987; Whitcomb et al. 1994; Hamilton 1995). Recent collections of Auchenorrhyncha in Great Lakes alvars have revealed a large number of species that are associated only with grasslands outside the study area. The objectives of this paper are to summarize data on the diversity and distribution of prairie endemic Auchenorrhyncha in Great Lakes alvars, and to comment on the use of Auchenorrhyncha in establishing conservation priorities within and among alvar regions.

Materials and Methods

Auchenorrhyncha were collected in 51 alvar sites around the Great Lakes between 1988 and 1997 (Fig. 1, Table I). The geographic division of major alvar regions used in Table I follows Catling and Brownell (1995). Ten sites (Table I) were sampled by PB using traps (pitfall, yellow pan, Malaise, flight intercept) and sweeping. Sampling at each of these sites was carried out from mid-May to mid-September of 1996 (sites 36, 37, 39, 40) and 1997 (sites 6, 12, 14, 15, 18, 21). Forty-one other alvar sites (Table I) were sampled using a sweep net from 30–90 minutes per site per visit by KGAH between 1988 and 1996 (Site 42 was sampled in the same way by PB). Most sites were visited at least once in June and in August. When both seasons could not be sampled independently, samples taken in July were presumed to represent the faunas of both seasons. Complete lists of Auchenorrhyncha collected are in Hamilton (1990, 1994a, 1995) and Bouchard (1997, 1998). Specimens are deposited in the Canadian National Collection of Insects (Ottawa, Ontario) and the Lyman Entomological Museum, McGill University (Ste-Anne-de-Bellevue, Quebec).

Species distributions were compiled from taxonomic publications, published surveys of northeastern native prairie relict sites and specimens housed in the Canadian National Collection of Insects. Vegetation types used in the distribution sections were taken from Risser et al. (1981). The taxonomy of vascular plants follows Gleason and Cronquist (1991).

Results

Eighteen species of prairie endemic Auchenorrhyncha in three families were recorded in Great Lakes alvars. In the following annotated checklist, the North American distribution of each species is given, followed by a list of alvar sites in which the species was collected and information on host plants.

Family Cicadellidae

1. *Aflexia rubranura* (DeLong)

Distribution: This flightless species is found in tallgrass prairies from southern Manitoba to South Dakota and east to Wisconsin and Illinois (Delong 1935, 1948; Panzer et al. 1995). Outside of tallgrass prairies, it is only found in Ontario alvars and dolomite ridges, which are similar to alvars but do not experience seasonal flooding (Hamilton 1994a, 1995; Bouchard 1997).

Alvar records: Sites 31–38, 40 (Fig. 2).

Host plant: Prairie dropseed, *Sporobolus heterolepis* Gray (Poaceae).

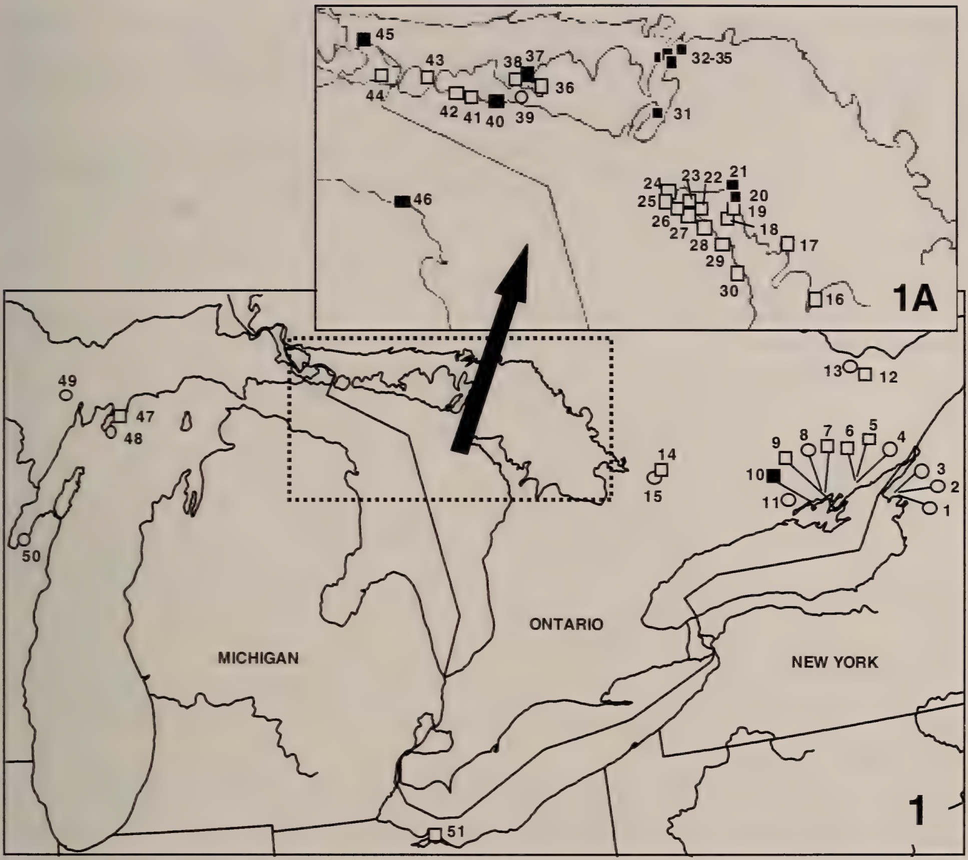


FIGURE 1. Alvar sites sampled in the Great Lakes region; rectangle shows area magnified in Figure 1A. Numbers correspond to site numbers in Table I. Symbols show number of prairie Auchenorrhyncha species at each site (circles: none; white squares: 1–3 species; black squares: 4–8 species).

2. ***Athysanella longicauda*** **Beirne**

Distribution: This species is found only in the northeastern United States and adjacent areas of Canada, from Wisconsin to southern Quebec. It occurs primarily in limestone areas, but not necessarily alvars. However, it is also known from igneous intrusions such as Mont Royal and Mont St-Hilaire, Quebec and a sand-based prairie relict at Brantford, Ontario. Its distribution in Canada corresponds closely to that of its only recorded host plant (Dore and McNeill 1976), suggesting that it is monophagous.

Alvar records: Sites 5, 7, 10, 12 (Fig. 3).

Host plant: Ensheathed dropseed, *Sporobolus vaginiflorus* (Torr.) Wood (Poaceae).

3. ***Auridius sandaraca*** **Hamilton**

Distribution: This species is known from five prairie localities in Alberta, Manitoba and Minnesota. It is also known from alvars in northern Michigan and Ontario and sand-based prairie relicts at Madawaska, Ontario and Epoufette Bay, Michigan (Hamilton 1999).

TABLE I. Alvar sites sampled between 1988 and 1997. Major alvar regions are in bold type. Site numbers correspond to those in Figure 1. Sites numbered in bold were sampled using pitfall, pan, flight intercept and Malaise traps and sweeping; all others were sampled by sweeping only. Numbers in right column refer to Auchenorrhyncha species numbers in annotated checklist.

Site	Locality	Prairie species present
Western New York		
1	Chaumont Barrens (44°05′N; 76°05′W)	-
2	Lucky Star (44°07′N; 76°07′W)	-
3	Three Mile Creek (44°08′N; 76°09′W)	-
Napanee Plain (Ontario)		
4	3 km S Yarker (44°22′N; 76°47′W)	-
5	5 km E Camden East, SE model aircraft club (44°20′N; 76°46′W)	2
6	5 km E Camden East, model aircraft club (44°20′N; 76°47′W)	16
7	3 km W Deseronto (44°12′N; 77°05′W)	2, 7, 11
8	2 km S Lonsdale (44°15′N; 77°07′W)	-
9	5 km S Marysville (44°10′N; 77°06′W)	11
10	Pointe Anne alvar (44°09′N; 77°18′W)	2, 6, 7, 11
11	7 km S Stirling (44°13′N; 77°33′W)	-
Smith Falls Plain (Ontario)		
12	5 km N Almonte (45°16′N; 76°10′W)	2, 12, 18
13	7 km SW Arnprior (45°20′N; 76°24′W)	-
Carden Plain (Ontario)		
14	7.5 km E Seabright (44°38′N; 79°03′W)	12
15	1.5 km NE Dalrymple (44°41′N; 79°05′W)	-
Bruce Peninsula (Ontario)		
16	Squaw Point, 4 km SW Leith (44°37′N; 80°54′W)	4, 11
17	Prairie Point, 3 km S Cape Crocker (44°55′N; 81°03′W)	4, 11
18	3 km N Miller Lake (45°07′N; 81°26′W)	15, 18
19	7 km NE Miller Lake (45°09′N; 81°23′W)	15
20	10 km E Dyer's Bay (45°13′N; 81°17′W)	3, 6, 8, 11, 18
21	Cabot Head (45°14′N; 81°18′W)	3, 5, 6, 11, 12, 14, 15,18
22	14 km SE Tobermory (45°11′N; 81°31′W)	15
23	Borden Road, 15 km SE Tobermory (45°09′N; 81°34′W)	5, 14
24	Cape Hurd, 6 km SW Tobermory (45°13′N; 81°43′W)	5
25	1 km N Baptiste Harbour, 5 km S Tobermory (45°13′N; 81°41′W)	15
26	Dorcas Bay Cons. Area, 8 km SE Tobermory (45°11′N; 81°36′W)	5, 14, 15
27	Johnston Harbour, 17 km SE Tobermory (45°07′N; 81°33′W)	5, 15
28	1 km E Pine Tree Harbour (45°05′N; 81°29′W)	5
29	Stokes Bay (45°00′N; 81°22′W)	5, 14
30	St-Jean Point, 1 km N Howdenvale (44°50′N; 81°19′W)	5, 15
Manitoulin and surrounding islands (Ontario)		
31	South Bay, 19 km SW Wikwemikong (45°50′N; 81°47′W)	1, 5, 11, 18
32	Little LaCloche Is. (45°59′N; 81°44′W)	1, 5, 8, 11, 12, 13, 15, 17
33	Great LaCloche Is., 13 km E Little Current (46 00′N; 81 46′W)	1, 5, 11, 12, 13
34	Great LaCloche Is., 5 km E Little Current (46°00′N; 81°51′W)	1, 3, 5, 11, 12, 13
35	Goat Island (45°59′N; 81°54′W)	1, 5, 9, 11, 12, 13, 14
36	10 km SW Gore Bay (45°52′N; 82°31′W)	1, 11, 15
37	10 km W Gore Bay (45°53′N; 82°34′W)	1, 5, 8, 11, 12, 14, 15, 18

TABLE I. Continued.

Site	Locality	Prairie species present
38	W extremity Barrie Island (45°55′N; 82°42′W)	1, 5, 12
39	10 km W Evansville (45°49′N; 82°41′W)	-
40	Misery Bay (45°47′N; 82°45′W)	1, 3, 5, 11, 12, 13, 14, 15
41	Burnt Island, 9 km SW Silver Water (45°50′N; 82°57′W)	5, 14
42	Belanger Bay (45°51′N; 83°01′W)	5
43	12 km W Meldrum Bay (45°54′N; 83°14′W)	6
Northern Michigan		
44	7 km ESE Johnswood (45°55′N; 83°32′W)	3
45	Maxton Plains alvar (46°04′N; 83°39′W)	3, 5, 8, 11, 14
46	North Point alvar, 11 km W Presqu'Ile (45°18′N; 83°47′W)	4, 5, 10, 11, 14
47	6 km S Garden (45°41′N; 86°31′W)	3, 9
48	3 km ENE Fairport (45°37′N; 86°35′W)	-
49	Cornell (45°53′N; 87°14′W)	-
Wisconsin		
50	4 km SW Dyckesville (44°37′N; 87°48′W)	-
Western Lake Erie (Ohio)		
51	Marblehead Peninsula (41°31′N; 82°43′W)	11

Alvar records: Sites 20, 21, 34, 40, 44, 45, 47 (Fig. 4).

Host plant: Kentucky bluegrass, *Poa pratensis* L. (Poaceae).

4. *Dorydiella kansana* Beamer

Distribution: This species is found in prairies of Kansas, Iowa and Illinois and in remnants of native prairie vegetation in Pennsylvania, Ohio, Michigan and Ontario (Beamer 1945; DeLong 1948; Hamilton 1994a, 1995).

Alvar records: Sites 16, 17, 46 (Fig. 5).

Host plants: *Eleocharis elliptica* Kunth (Cyperaceae). It has also been recorded from *Scleria* spp. (Cyperaceae) in Pennsylvania (as *Dorydiella floridana*) by DeLong (1923).

5. *Flexamia delongi* Ross and Cooley

Distribution: This species is found in tallgrass prairies from southern Manitoba to Illinois and it is abundant almost anywhere its host plant occurs in Ontario, Michigan and Ohio (Whitcomb and Hicks 1988; Hamilton 1994a, 1995; Panzer et al. 1995; Bouchard 1997, 1998).

Alvar records: Sites 21, 23, 24, 26–35, 37, 38, 40–42, 45, 46 (Fig. 6).

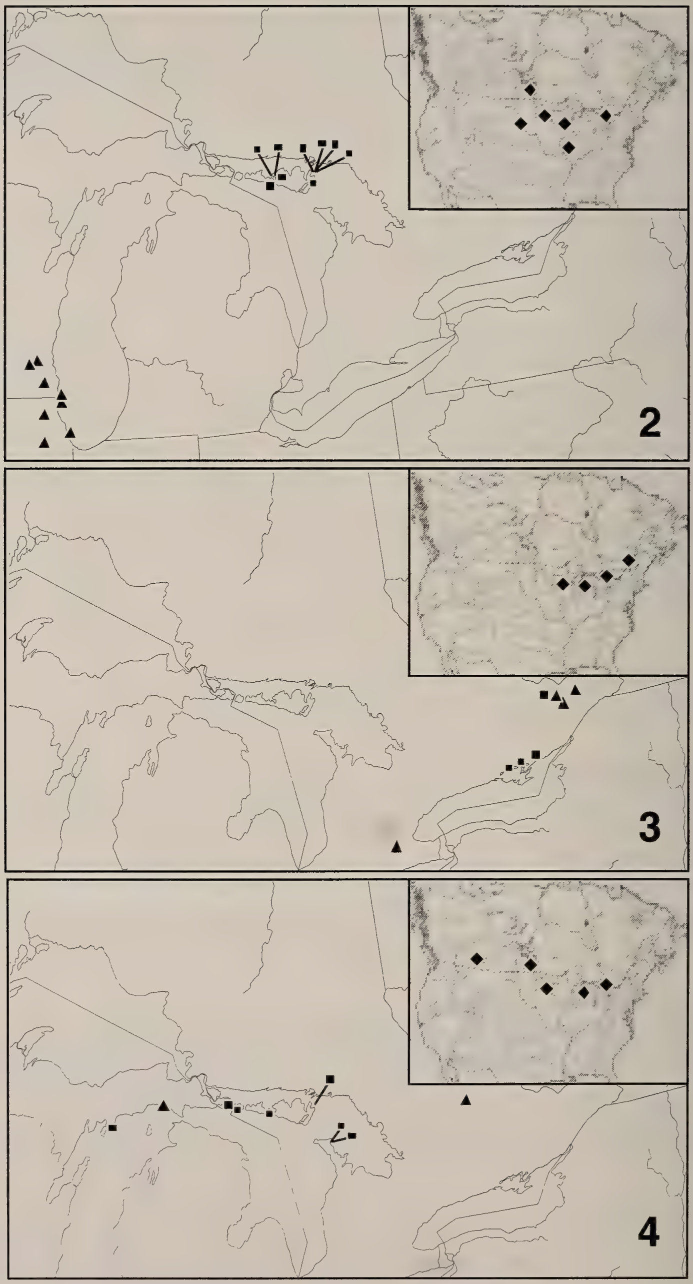
Host plant: Little bluestem, *Schizachyrium scoparium* (Michx.) Nash. (Poaceae).

6. *Graminella mohri* DeLong

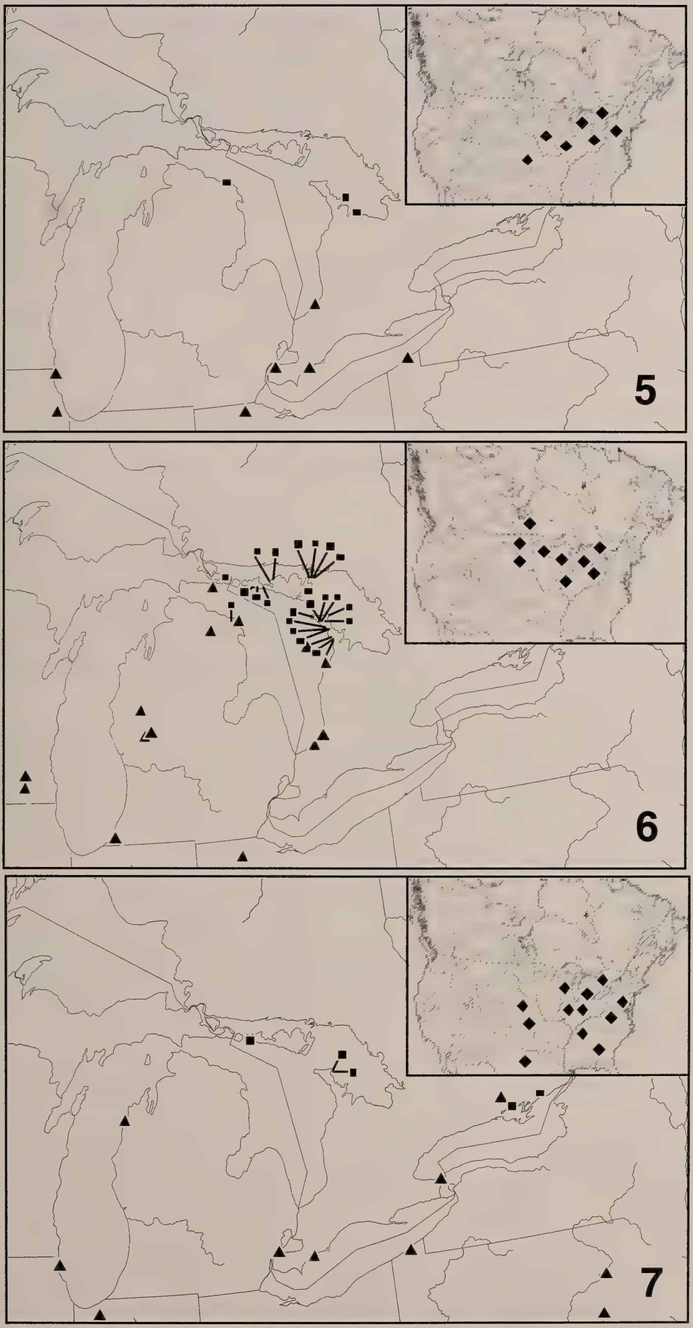
Distribution: This species is known from the shortgrass prairie of Texas, Kansas and Nebraska, east to Georgia and Tennessee and north to the tallgrass prairies of Wisconsin and Illinois (Kramer 1967; Panzer et al. 1995). It has also been found in prairie remnants in Ontario and Michigan (Hamilton 1994a, 1995; Bouchard 1998).

Alvar records: Sites 10, 20, 21, 43 (Fig. 7).

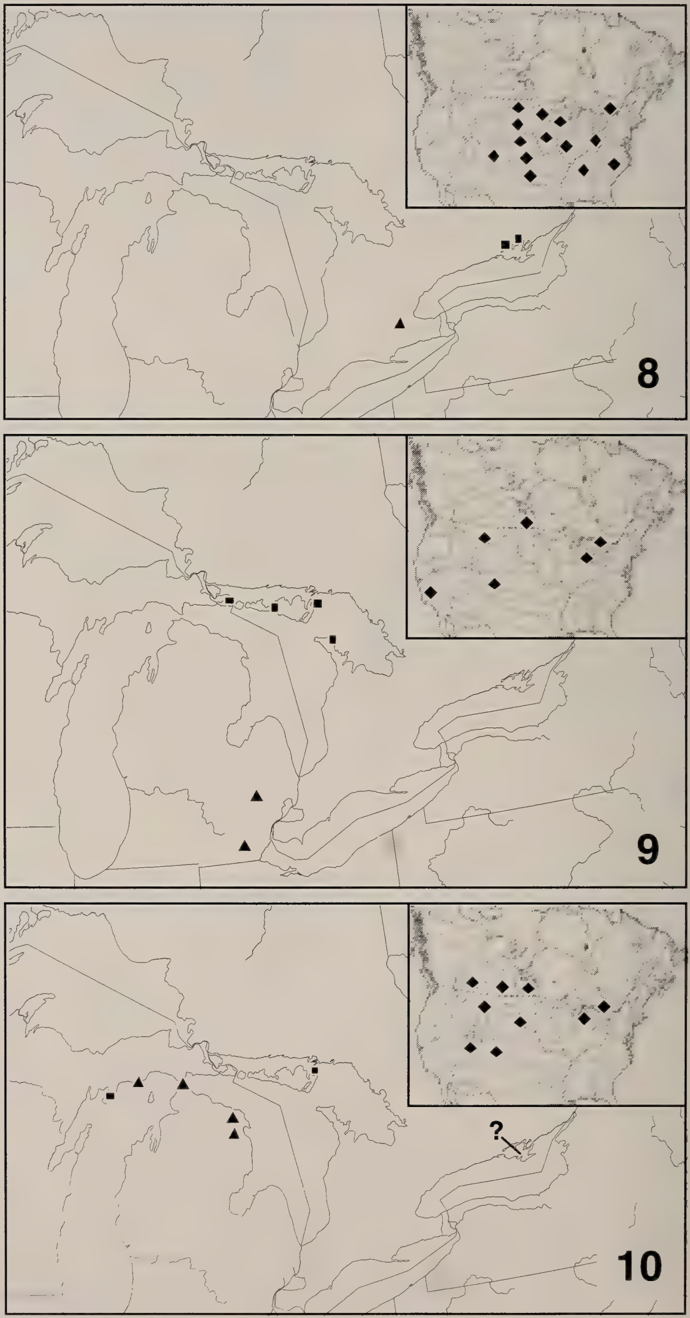
Host plant: Switchgrass, *Panicum virgatum* L. (Poaceae).



FIGURES 2–4. Distribution of *Aflexia rubranura* (2), *Athysanella longicauda* (3) and *Auridius sandaraca* (4) in the study area. Squares: occurrence in alvar sites; triangles: occurrence in non-alvar sites. Inset map shows North American distribution by state and province.



FIGURES 5–7. Distribution of *Dorydiella kansana* (5), *Flexamia delongi* (6) and *Graminella mohri* (7) in the study area. Legend as in Figures 2–4.



FIGURES 8–10. Distribution of *Laevicephalus minimus* (8), *Limotettix balli* (9) and *Limotettix bisoni* (10) in the study area. Legend as in Figures 2–4.

7. *Laevicephalus minimus* (Osborn and Ball)

Distribution: This species is widespread on the prairies as far north as Wisconsin and Illinois (Ross and Hamilton 1972), entering southern Ontario in Napanee Plain alvars and a single prairie relict near Brantford (Hamilton 1995). The species may be a good disperser, but its occurrence in two eastern relict populations of the host plant, separated by at least 200 km from each other and the prairie populations (Dore and McNeill 1976), probably reflects a reduction in the abundance and range of the host plant since the end of the Hypsithermal warming interval (5000 bp).

Alvar records: Sites 7, 10 (Fig. 8).

Host plant: Side-oats grama, *Bouteloua curtipendula* (Michx.) Torr. (Poaceae).

8. *Limotettix balli* (Medler)

Distribution: This species is known from California grasslands and the bunchgrass steppes of Montana and Colorado, in prairies of southern Manitoba and east to relicts of native vegetation in Michigan and Ontario (Medler 1958; Hamilton 1995).

Alvar records: Sites 20, 32, 37, 45 (Fig. 9).

Host plant: The host plant of this species is unknown, but is probably a species of Ericaceae.

9. *Limotettix bisoni* Knull

Distribution: This species is found in the northern mixed-grass prairies of Manitoba, Saskatchewan, Alberta, Montana and South Dakota, in bunchgrass steppes of Colorado and Utah (Knull 1952; Panzer et al. 1995) and in native vegetation remnants in Michigan and Ontario.

Alvar records: Sites 35, 47 (Fig. 10).

Host plant: Spikerush, *Eleocharis* spp. (Cyperaceae).

10. *Limotettix elegans* Hamilton

Distribution: This species has a bicentric distribution. It is known in the south in prairies of Texas, Missouri and Oklahoma and in the north in very few prairie remnants of Ontario, Michigan and Ohio (Hamilton 1994b, 1995).

Alvar records: Site 46 (Fig. 11).

Host plant: Low spikerushes, *Eleocharis elliptica* and *E. compressa* Sulliv. (Cyperaceae).

11. *Limotettix urnura* Hamilton

Distribution: This species is common in northern mixed-grass and tallgrass prairies from Saskatchewan east to Ontario, south to Kansas, Colorado and Utah (Hamilton 1994b; Panzer et al. 1995). It is found in Great Lakes alvars where the host plant occurs (Hamilton 1995; Bouchard 1997, 1998).

Alvar records: Sites 7, 9, 10, 16, 17, 20, 21, 31–37, 40, 45, 46, 51 (Fig. 12).

Host plant: *Eleocharis elliptica.*

12. *Memnonia panzeri* Hamilton (= *Parabolocratus grandis* sensu DeLong, 1948 nec Shaw)

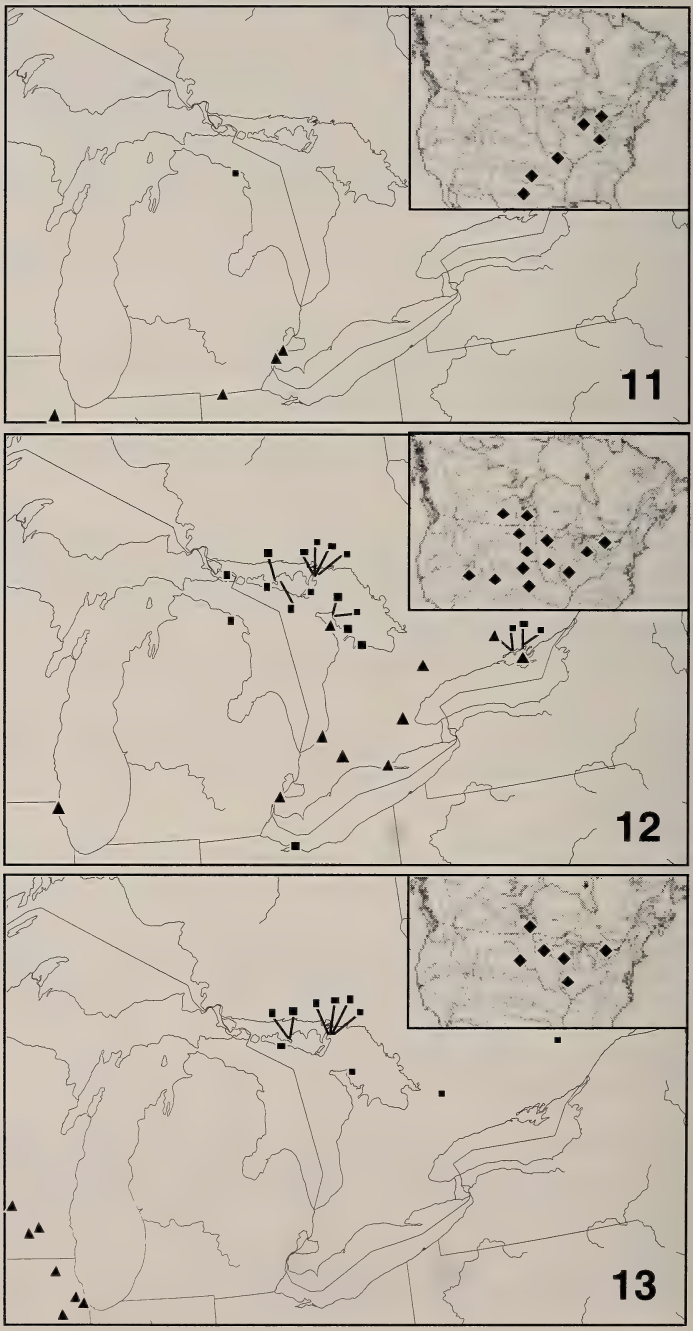
Distribution: This flightless species is found in tallgrass prairies of Manitoba, South Dakota, Minnesota, Wisconsin and Illinois and in Ontario alvars (Bouchard 1997, 1998 (as *Memnonia n. sp.*); Hamilton 2000).

Alvar records: Sites 12, 14, 21, 32–35, 37, 38, 40 (Fig. 13).

Host plant: Prairie dropseed, *Sporobolus heterolepis.*

13. *Mocuellus americanus* Emeljanov

Distribution: This species is found in the northern mixed-grass prairies of Saskatchewan, Alberta and Montana, in tallgrass prairies of Manitoba, North Dakota and Minnesota and reaches



FIGURES 11–13. Distribution of *Limotettix elegans* (11), *Limotettix urnura* (12) and *Memnonia panzeri* (13) in the study area. Legend as in Figures 2–4.

its eastern limit in alvars of Manitoulin and surrounding islands (Hamilton 1994a, 1995; Bouchard 1997).

Alvar records: Sites 32–35, 40 (Fig. 14).

Host plant: Slender wheatgrass, *Elymus trachycaulus* (Link) Gould (Poaceae).

14. *Paraphlepsius lobatus* (Osborn)

Distribution: This species is characteristic of the central Great Plains. It is found from Manitoba south to Kansas and Oklahoma (Hamilton 1975a; Panzer et al. 1995) and west to Alberta. In the east it is present mostly in alvar habitats in Ontario and Michigan (Hamilton 1994a, 1995; Bouchard 1997, 1998).

Alvar records: Sites 21, 23, 26, 29, 35, 37, 40, 41, 45, 46 (Fig. 15).

Host plant: Little bluestem, *Schizachyrium scoparium.*

15. *Texananus marmor* (Sanders and DeLong)

Distribution: This species is found in the northern mixed-grass prairies of Alberta, Saskatchewan, Manitoba and Montana and reaches its eastern limit in southern Ontario where it occurs exclusively in alvars (Hamilton 1972, 1994a, 1995; Bouchard 1997, 1998). It is particularly abundant on the Bruce Peninsula.

Alvar records: Sites 18, 19, 21, 22, 25–27, 30, 32, 36, 37, 40 (Fig. 16).

Host plant: Creeping juniper, *Juniperus horizontalis* Moench (Cupressaceae).

16. *Xerophloea major* Baker

Distribution: This southeastern species has been collected in small numbers from Kansas and Oklahoma east to North Carolina and Virginia and north to the tallgrass prairies of Illinois and Wisconsin and prairie remnants of Ontario and New York (Nielson 1962; Hamilton 1975b, 1995; Panzer et al. 1995; Bouchard 1998).

Alvar records: Site 6 (Fig. 17).

Host plants: Bee-balm, *Monarda* spp. (Labiaceae) and other forbs.

Family Caliscelidae

17. *Bruchomorpha dorsata* Fitch

Distribution: This species is found from the northern mixed-grass prairies of Saskatchewan, east through the tallgrass prairies of Manitoba, Minnesota, Wisconsin and Illinois, and south to Colorado, Texas and North Carolina (Dozier 1926; Ball 1935). It is also found in a small number of native prairie remnants in Michigan, New York, Ohio and Ontario (Hamilton 1995).

Alvar records: Site 32 (Fig. 18).

Host plant: Not known, but probably bluestem grasses (*Andropogon* and *Schizachyrium* spp.)

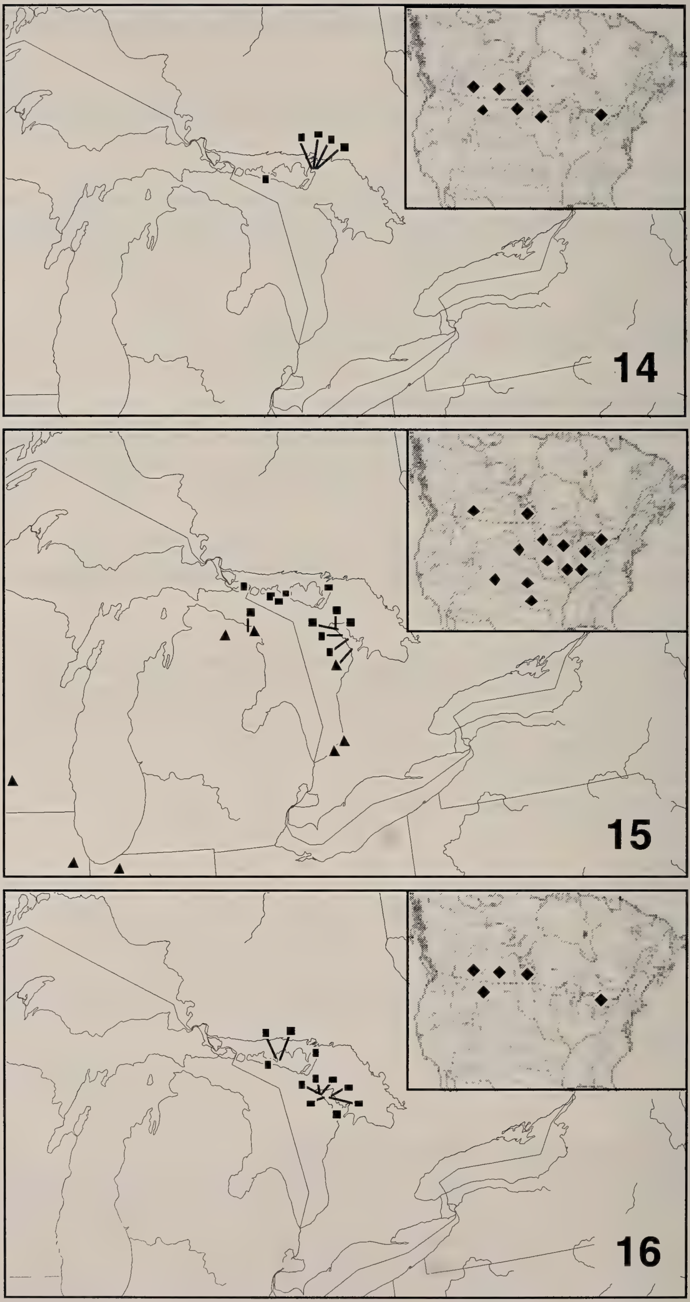
Family Delphacidae

18. *Caenodelphax nigriscutellata* (Beamer) n. comb.

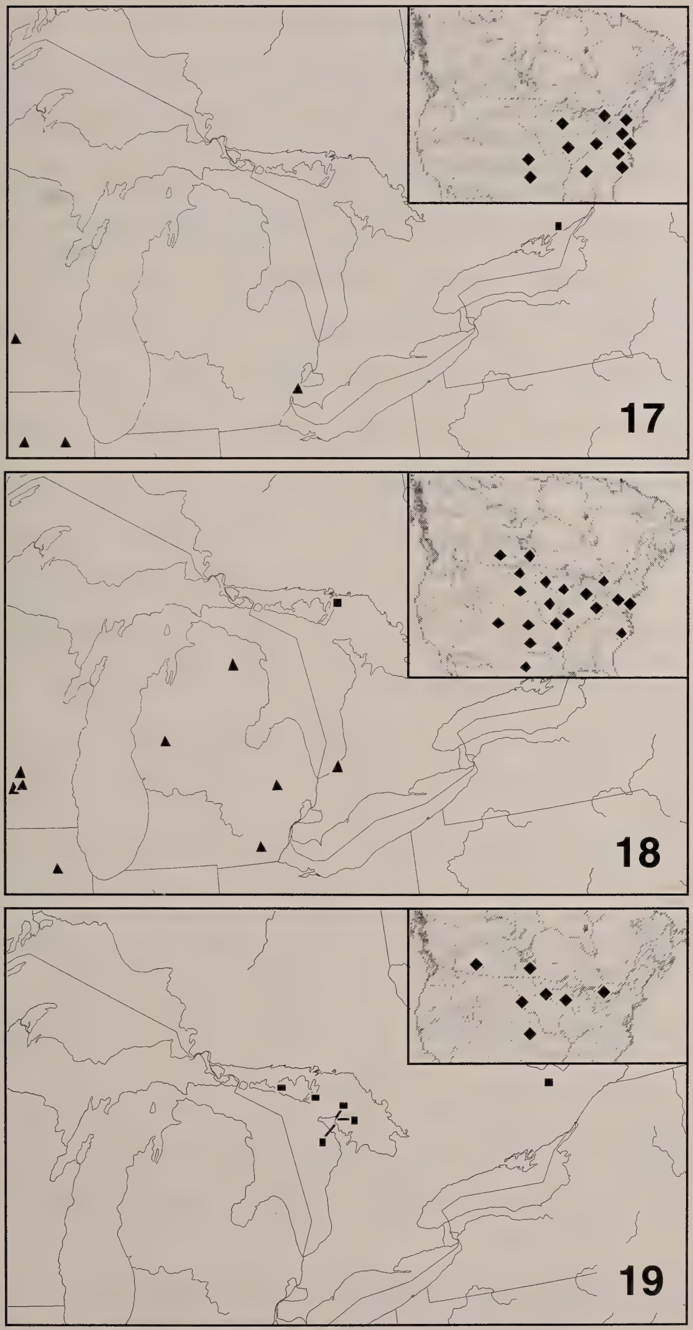
Distribution: This species is found in the northern mixed-grass and tallgrass prairies from Alberta to Manitoba in the north, south to prairies of South Dakota and Kansas (Beamer 1947). It is also found in alvar habitats in the Great Lakes region where it reaches its eastern limit near Ottawa (Bouchard 1997, 1998). *Caenodelphax nigriscutellata* is a new combination, transferred from the genus *Delphacodes* Fieber on the basis of its polished face and contrasting white antennae.

Alvar records: Sites 12, 18, 20, 21, 31, 37 (Fig. 19).

Host plants: *Eleocharis compressa* and *E. elliptica.*



FIGURES 14–16. Distribution of *Mocuellus americanus* (14), *Paraphlepsius lobatus* (15) and *Texananus marmora* (16) in the study area. Legend as in Figures 2–4.



FIGURES 17–19. Distribution of *Xerophloea major* (17), *Bruchomorpha dorsata* (18) and *Caenodelphax nigriscutellata* (19) in the study area. Legend as in Figures 2–4.

Discussion

Origin and distribution of prairie endemic Auchenorrhyncha in Great Lakes alvars

Two historical events have had a major influence on the present biotic composition of Great Lakes alvars: the Wisconsinan glaciation (23,000–10,000 bp) and the Hypsithermal warming interval (8,000–5,000 bp) (Matthews 1979). The Great Lakes region was glaciated until about 12,000 bp and the limestone bedrock underlying most of the alvar sites was scoured by retreating glaciers (Morton and Venn 1984). Most of the cold-adapted species that were associated with tundra habitats south of the ice sheets during the Wisconsinan glaciation moved northward during deglaciation and the subsequent advance of the boreal forest (Scudder 1979). Such species are currently distributed in arctic and boreal regions of Canada although some northern plants (e.g. *Allium schoenoprasum* L. (Liliaceae), *Poa alpina* L. (Poaceae), *Carex scirpoidea* Michx. (Cyperaceae)) are believed to have persisted postglacially in Great Lakes alvars as disjuncts near the southern limit of their range (Catling and Brownell 1995).

The herbaceous vegetation of most Great Lakes alvars is dominated by native prairie-associated grasses and sedges which probably reached the area from the west and south during the Hypsithermal. Species such as *Sporobolus heterolepis, Carex crawei* Dewey (Cyperaceae), *Geum triflorum* Pursh (Rosaceae) and *Orobanche fasciculata* Nutt. (Orobanchaceae) are widespread in western North America and extend narrowly eastward into the Great Lakes alvars (Catling and Brownell 1995). These and several other plants may have dispersed eastward during the Hypsithermal, bringing with them a characteristic community of plant feeding invertebrates such as the skipper *Oarisma garita* (Reakirt) (Lepidoptera: Hesperiidae) and the flightless Auchenorrhyncha species *Aflexia rubranura* and *Memnonia panzeri.* Southern plant species such as *Carex juniperorum* Catling, Reznicek and Crins (Cyperaceae) and *Hypoxis hirsuta* (L.) Cov. (Liliaceae) reach their northern limits in alvars (Catling and Brownell 1995).

The North American distribution of the Auchenorrhyncha species discussed in this paper suggests that alvar habitats share components of the Auchenorrhyncha fauna with all of the major types of native prairies. Alvars of northern Michigan, Manitoulin and surrounding islands and the Bruce Peninsula share the greatest number of prairie Auchenorrhyncha species (Table I) which suggests a similar postglacial history. The alvar communities of the Smith Falls Plain, northern Michigan, Manitoulin and surrounding islands and the Bruce Peninsula were formed just preceding or during the Hypsithermal as lower water levels enabled western prairie-associated plants and animals to disperse eastward on dry land connections across Lake Huron (Hamilton 1994a). This hypothesis is supported by the presence of two prairie Auchenorrhyncha species: *Caenodelphax nigriscutellata* (Fig. 19); and *Memnonia panzeri* (Fig. 13) in alvars of the Smith Falls Plain, Manitoulin and surrounding islands and the Bruce Peninsula. The prairie Auchenorrhyncha found in the above alvar regions are mostly characteristic of northern mixed-grass and tallgrass prairies.

In contrast, the alvar communities of western Lake Erie, the Napanee Plain and western New York were probably formed in the late Hypsithermal when southern prairie communities reached their northern limits during postglacial temperature maxima (Hamilton 1994a). *Xerophloea major* (Fig. 17), collected to date only in the Napanee Plain alvar region (although it is a rarely collected species that occurs in low numbers in other sites), is an example of a species associated with southern prairies.

Diversity and conservation of prairie endemic Auchenorrhyncha in Great Lakes alvars

Hamilton (1995) developed a ranking system to assess the quality of northeastern prairie remnants based on the number of prairie endemic Auchenorrhyncha found within them. According to that ranking system, most alvar sites sampled in this study were of depauperate or poor quality (i.e. supporting 0–3 prairie Auchenorrhyncha species). These included all sites in the western

New York, Smith Falls Plain, Carden Plain, Wisconsin and Western Lake Erie regions, and most Napanee Plain alvars. However, 12 sites (10, 20, 21, 31–35, 37, 40, 45, 46) were of fair to good quality (4–8 prairie species) compared to tallgrass prairies of Wisconsin, Minnesota and Manitoba (Hamilton 1995). No sites were of very good quality (nine or more prairie endemic species), although sites 21, 37 and 40 had eight species. The fair to good quality sites, mostly restricted to the Bruce Peninsula, Manitoulin and surrounding islands and Northern Michigan alvar regions (Figure 1, Table I) had more species of prairie endemic Auchenorrhyncha than any native vegetation remnants in Ontario and Michigan, except for the Newago Plain (Michigan), Ipperwash Beach and Windsor prairies (Ontario) (Hamilton 1995).

The number of prairie endemic Auchenorrhyncha species varied greatly from one alvar region to another and also from site to site within a given region. This was expected because of variation in vascular plant species composition between and within alvar regions (Belcher and Keddy 1992). Three species of Auchenorrhyncha (*Mocuellus americanus, Texananus marmor, Caenodelphax nigriscutellata*) are restricted to alvars in the Great Lakes region and two others (*Aflexia rubranura, Memnonia panzeri*) are restricted to alvars in the study area as well as some prairie remnants in Wisconsin and Illinois. These five species deserve prime attention from a conservation point of view. Six species have been collected in only one alvar region, which means that one or more sites in which they occur should also be included in conservation efforts. These species include *Laevicephalus minimus* and *Xerophloea major* (Napanee Plain), *Aflexia rubranura*, *Mocuellus americanus* and *Bruchomorpha dorsata* (Manitoulin and surrounding islands) and *Limotettix elegans* (Northern Michigan).

The three alvar regions which supported the highest numbers of prairie endemic Auchenorrhyncha were the Bruce Peninsula, Manitoulin and surrounding islands and Northern Michigan. These regions should, therefore, receive the most attention from a conservation perspective. However, we also agree with Catling and Brownell (1995) who suggested that within each of the alvar regions around the Great Lakes, it would be necessary to protect two or three high quality sites in order to achieve adequate representation of the various association types. From this point of view, the data on prairie endemic Auchenorrhyncha could help to choose between a number of sites with equal conservation value based on vascular plant data. For example, in the event that all the Napanee Plain alvar sites investigated in this study (sites 4–11, Table I) had equal weight based on vascular plant data, information on Auchenorrhyncha would make a strong case for the protection of sites 6 and 10. Indeed, the protection of these two sites would enhance the chances of preserving representative populations of all five prairie Auchenorrhyncha species present in that alvar region. In the Smith Falls Plain, the only prairie endemic species were found in site 12, which should also receive higher conservation priority.

Because of the overall rarity of alvars worldwide and their vulnerability to increasing anthropogenic pressures, the need to protect an adequate number of representative alvar communities has received much attention in recent years (Belcher and Keddy 1992; Catling and Brownell 1995; Reschke et al. 1999). Thus far, the evaluation of the habitat health and quality of North American alvars has been based almost entirely on the vascular plants. It is our opinion that data from additional groups such as the Auchenorrhyncha should be incorporated into future conservation decisions to complement vascular plant data and provide more comprehensive information on these biologically significant areas for the use of land owners and policy makers.

Acknowledgments

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BEETLES OF THE BOREAL FOREST: A FAUNISTIC SURVEY CARRIED OUT IN WESTERN QUÉBEC

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Abstract *Proc. ent. Soc. Ont.* 132: 57–98

The beetle fauna of two important regions of the eastern boreal forest of Canada were surveyed in western Quebec: 1) the mixed boreal zone (south boreal) and 2) the black spruce succession (north boreal). Seven forest habitats were studied, three in the south boreal zone (deciduous, mixed, and coniferous) and four in the northern one (burned, regenerating, mature, and old growth). A total of 9,505 samples yielded 94,555 specimens, representing 69 families. All specimens were identified for a total of 757 species (excluding 20,000 unidentified Aleocharinae). Species are listed in alphabetical order and abundance is given for the seven forest habitats studied. The list contains 5 new records for North America, 4 for Canada, 21 for Quebec, 2 confirmations of doubtful records, numerous important range extensions and some ecological observations. The total number of species and number of specimens are compared between all families and between subfamilies of Staphylinidae. The high number of species and specimens collected highlights the importance of Staphylinidae. Predators dominate with 39% of the species while mycophages account for 29%. Phytophages (12%), xylophages (dead wood) (11%), and saprophages (6%) follow, while the remaining guilds occupy each 1%, or less. Beetle diversity in boreal forest is more related to decaying processes than to living plants.

Résumé *Proc. ent. Soc. Ont.* 132: 57–98

La faune des coléoptères de deux importantes zones de la forêt boréale canadienne a été inventoriée dans l'ouest du Québec : 1) la forêt boréale mixte (boréal sud) et 2) la succession écologique des forêts d'épinettes noires (boréal nord). Sept types d'habitats forestiers ont été échantillonnés, trois dans la région sud (forêts décidues, mixtes et conifériennes) et quatre dans la région nord (forêts brûlées, en régénération, matures et anciennes). Un total de 9505 échantillons contenant 94 555 spécimens et 69 familles a été prélevé. Tous les spécimens (sauf 20 000 Aleochaninae) ont été identifiés, et 757 espèces ont été reconnues. Les espèces sont énumérées par ordre alphabétique et l'abondance dans chacun des 7 habitats forestiers est donnée. La liste contient 5 nouvelles mentions pour l'Amérique du Nord, 4 pour le Canada, 21 pour le Québec, la confirmation de deux espèces, plusieurs importantes extensions d'aires de distribution et quelques observations écologiques. La richesse et l'abondance des espèces sont comparées entre les familles, mais aussi entre les sous-familles de Staphylinidae. L'importance des Staphylinidae dans les forêts boréales est démontrée par leur grande richesse et abondance. Les prédateurs dominent avec 39% des espèces récoltées, tandis que les mycophages occupent 29%. Les phytophages (12%), les xylophages (associés au bois mort) (11%), et les saprophages (6%) suivent;

les autres guildes n'occupent que 1%, ou moins, des effectifs. La diversité des coléoptères des forêts boréales est davantage liée à la décomposition qu'àux plantes vivantes.

Introduction

The boreal forest is the largest continuous vegetation zone in North America and it forms a vast transcontinental belt (Scudder 1979). Disturbance regimes have a strong influence on the landscape dynamic, particularly forest fires which are the most important natural factor. Their devastating effects determine a natural starting point for the ecological succession and maturation processes (Rowe and Scotter 1973; Bonan and Shugart 1989). Independence of fires and their semi-random recurrence create a diverse forest habitat made of serial stages, forming the characteristic boreal heterogeneous landscape (Danks and Foottit 1989). Despite the geographical and economical importance of the ecosystem, few extensive inventories have been conducted on its invertebrate fauna, especially in eastern boreal forests. Most of our knowledge on beetles is deduced from ecological studies limited to a few families, namely on Carabidae, carried out in Alberta and Manitoba (Richardson and Holliday 1982; Holliday 1984, 1991a, b; Niemelä et al. 1992, 1993; Spence et al. 1996).

The present paper provides a species list of beetles and faunistic information gathered in an extensive ecological study of boreal forest in western Quebec. This region is of interest because of the variety of forest habitats found within this small area. The study covers two ecological successions: 1) the mixed-boreal succession (southern) in which the deciduous, mixed and coniferous phases were sampled and 2) the black spruce zone (northern succession) in which a) burned, b) regenerating, c) mature, and d) old growth phases were studied. In eastern Canada, the strong climatic influence of Hudson and James Bays creates northern conditions at a much lower latitude than anywhere else in the country (Danks 1979; Paquin and Dupérré 2001) as shown by the black spruce distribution across Canada (Rowe 1972). Therefore, the proximity of these two forest systems in western Quebec allows a comprehensive sampling of the boreal forest system.

The objectives of our study are 1) to provide an accurate list of beetles collected within the eastern boreal forest, 2) to add information on interesting records and species distributions and 3) to discuss the beetle fauna, family occurrence and dominance.

Methods

Study area

All study sites were located in the Northern Clay Belt of Quebec (Fig. 1) that resulted from the maximum extension of pro-glacial Lakes Barlow and Ojibway (Veillette 1994). Surface deposits, drainage, and time elapsed since the last forest fire determine the forest dynamics and composition (Leduc et al. 1995).

The mixed-boreal succession (also called southern succession) was studied in the Lake Duparquet area in Abitibi-ouest (48°30'N, 79°13'W). The forest dynamic is characterized by a tree succession in which pioneer deciduous species are gradually replaced by conifers. The young stages (less than 100 years old) are composed of aspen (*Populus tremuloides* Michx.) forming a purely deciduous forest; the intermediary stages (100 to 200 years old) are composed of balsam fir (*Abies balsamea* (L.) Mill.), white spruce (*Picea glauca* (Moench) Voss), paper birch (*Betula papyrifera* Marsh.) and a few *P. tremuloides* Michx. constituting a mixed forest; and the older stages (200 years and older), dominated by white cedar (*Thuja occidentalis* L.) and balsam fir (*Abies balsamea* (L.) Mill.), form a coniferous forest (Bergeron and Dubuc 1989; Bergeron and Dansereau 1993; Bergeron 2000). De Granpré et al. (1993) described the understory vegetation of

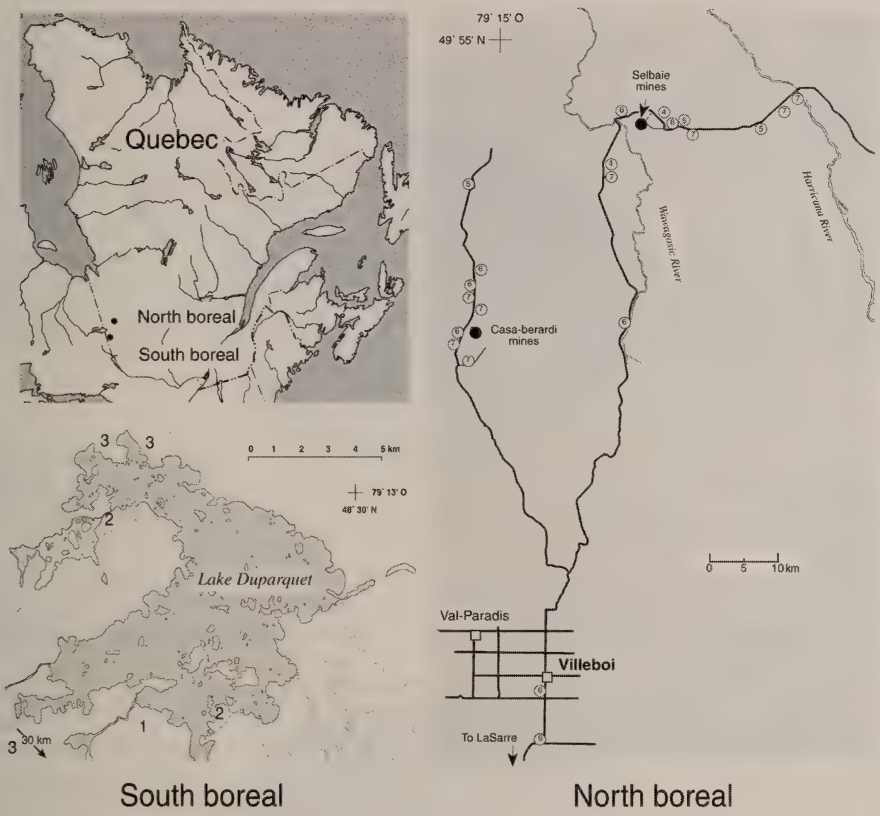


FIGURE 1. Study area. Locations of the two study regions: The mixed-boreal area (south boreal) and the north boreal area in the black spruce ecological succession. Detail of the south boreal area of Lake Duparquet showing locations of forest type 1 (deciduous), 2 (mixed), and 3 (coniferous). Detail of the north boreal area showing locations of forest type 4 (burned), 5 (regenerating), 6 (mature) and 7 (old-growth).

the chronosequence. Four stages were selected to represent the major steps of the chronosequence: deciduous, mixed, coniferous (two ages) respectively of 51, 148, 235 and 407 years of age at time of sampling. The oldest maturation phase is located in the Lake Labyrinthe in Témiscamingue (30 km S-E of Lake Duparquet).

On clayish soils, the northern succession is largely dominated by black spruce (*Picea mariana* Mill. B.S.P.) in all succession stages (Grandtner 1966; Rowe 1972; Bergeron et al. 2001). The study sites were located in the Jamésie (Baie James, Territoire-du-Nouveau-Québec), approximately 90 km north of La Sarre. The 21 sites are classified into four groups according to their respective age, i.e. time after forest fires: the burned phase in which traces of fire are still found (0–2 years old), the regeneration phase where black spruce has not yet established a closed canopy (21–58 years old); the mature phase with a complete canopy structure (70–170 years old), and old growth phase where the older cohort of trees is declining creating an opening of the crown (177–340 years old). All northern sites were located within a 60 km circle from the middle point — 49°33′N, 78°59′W — of the black spruce succession study area.

Sampling

The sampling season extended mainly from the end of May to late October in 1994, 1996 and 1997. Several trapping methods were used, including pitfall traps, canopy-funnels (see Martin 1966), flight-interception traps, Malaise/flight-interception traps and emergence cages. The Malaise/flight-interception trap combined a traditional Malaise trap and water pans added at the bottom of each panel. The specimens accumulated within the collecting head were noted 'top' on labels while those from the water pans were noted 'pan'. Emergence cages (1 m × 1 m) were placed on forest floors and specimens were either collected with the collecting head (noted 'top') or with a small water pan placed inside the cage, therefore noted 'pan'. All devices were serviced once a week. In addition, soil samples and microhabitat samples (10 liters of diverse organic matter, such as decaying logs, fungi, etc.) were collected and extracted with a Berlese funnel five times during the season, for a total 4,500 liters extracted.

Results

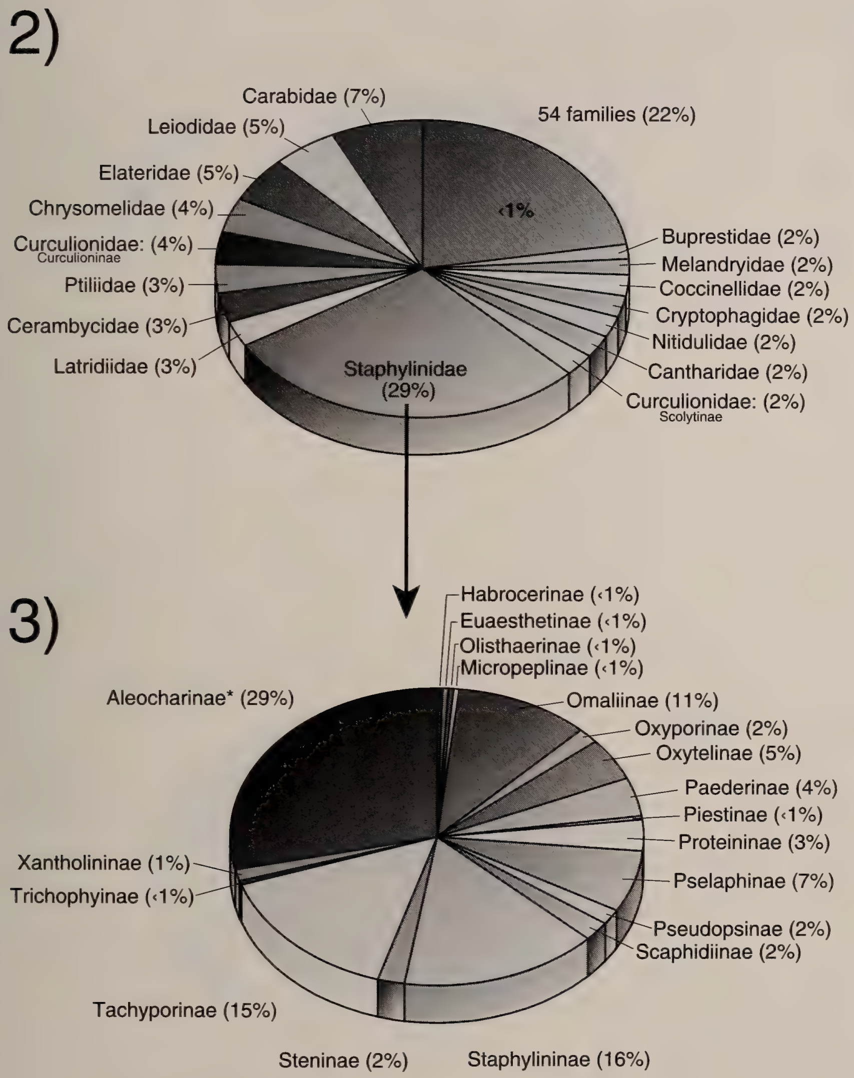
A total of 9,505 samples yielded 94,555 specimens, representing 69 families following the classification used in Arnett and Thomas (2000, in press). A total of 20,000 Aleocharinae (Staphylinidae) were sorted and mounted, but are not yet identified. This subfamily will be considered in detail in a later publication. However, Aleocharinae usually represent 40% of the total number of Staphylinidae species found (J. Klimaszewski, pers. comm.) which suggests a richness of 68 species. Consequently, the proportions given in Figures 2, 3, and 4 include Aleocharinae (based on 20,000 specimens and 68 species) to provide a better global picture of the beetle fauna associated with the boreal forest.

A total of 757 species were identified and are presented alphabetically by family and species name in Table 1. For each species, the abundance recorded in each of the seven forest types is given. Numbers refers to the appendix in which additional information on distribution, new records and ecological observations are found. All available data are given for new records and rare species, but only relevant information is given for range extensions. The list contains 5 new records for North America, 4 for Canada, 21 for Quebec, 2 confirmations of doubtful records and numerous important range extensions. Laplante et al. (1991) and Bousquet's (1991a) lists were used as references for new records, unless specified otherwise.

Staphylinidae represent the highest proportion of the species richness, with 29% (238 species) of all the beetles species collected (Fig. 2). The proportion decreases to 7% (59 species) with the Carabidae, then to 6% (49 species) for the Curculionidae (now including Scolytinae) and to 5% for the Leiodidae and Elateridae (42 and 41 species). Twelve other families represent between 4 and 2% of the fauna (31–13 species). The other 54 families account for a total of 22% of the species but individually represent less than 1% of the richness.

The subfamily level is the most widely used taxonomical unit in the Staphylinidae, especially with the recent changes in the family limits that now consider Pselaphinae and Scaphidiinae as subfamilies (Newton et al. 2000). The contribution of the 19 Staphylinidae subfamilies is given in Figure 3, where Aleocharinae dominate with 29% of the species. The Staphylininae (16%), Tachyporinae (15%), Omaliinae (11%), Pselaphinae (7%), and Oxytelinae (5%) follow and the remaining 13 subfamilies each represent less than 4%.

The number of specimens is largely dominated by the Staphylinidae with 53% (49,781 specimens including Aleocharinae) of the total number of specimens collected (Fig. 4). Ptiliidae rank second with 16% (15,311 specimens) then Latridiidae (4%), Carabidae (4%), Leiodidae (3%) and Nitidulidae (3%) which each harbour a high number of abundant species. However, Hydrophilidae (2%) and Brentidae (2%) are in the most abundant families because of the high number of two

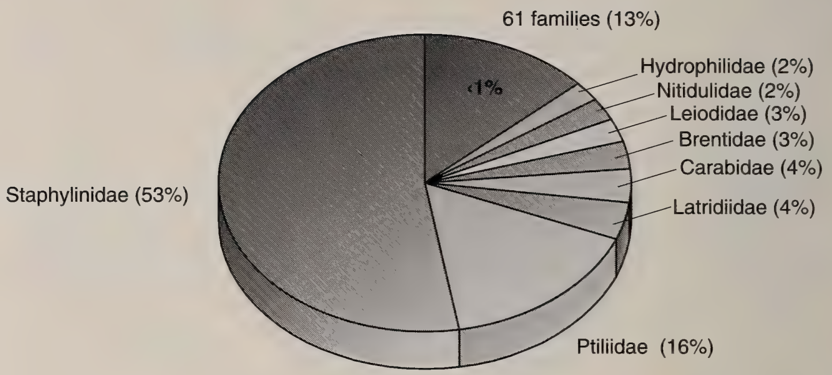


FIGURES 2–3. (2) Distribution of species in the 69 families collected. (3) Distribution of species in the 19 subfamilies of Staphylinidae collected. * Aleocharinae proportions are based on a 40% ratio of Staphylinidae.

species: *Cercyon assecla* Smetana and *Betulapion simile* (Kirby) respectively. The remaining 61 families represent 13% only of the specimens collected in which each family count for 1% or less.

The proportions given in Figure 5 illustrate the trophic structure of the boreal beetle fauna. Predators dominate with 39% while mycophages account for 29%. Phytophages (12%), xylophages (dead trees) (11%) and saprophages (6%) follow, while the remaining groups occupy 1%, or less, each.

4)



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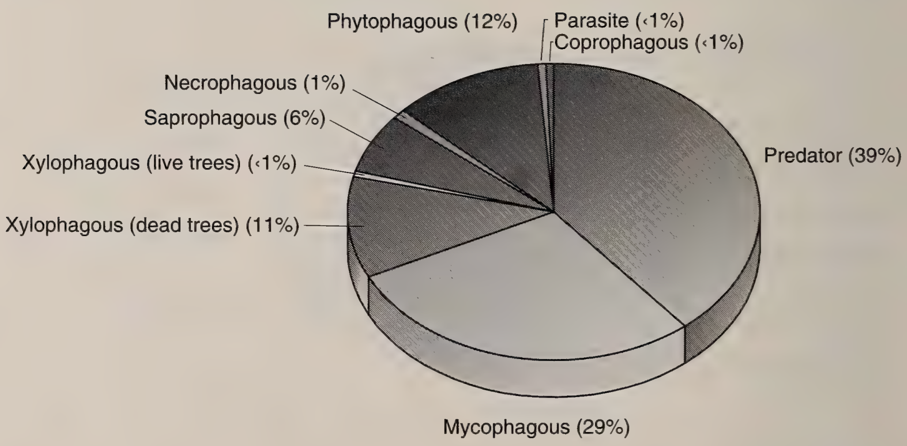

FIGURES 4–5. (4) Distribution of number of specimens in the 69 families collected. Staphylinidae includes Aleocharinae. (5) Trophic guild proportions of the boreal beetle community (Aleocharinae excluded).

TABLE I. List of species organized alphabetically by family and species name. Abundance in each of the 7 forest types is given. Forest types 1, 2 and 3 are located in the mixed boreal area (south boreal) and respectively forms the deciduous, mixed and coniferous stands. Forest types 4, 5, 6 and 7 are located in the black spruce boreal area (north boreal) and respectively form the burned, regenerating, mature and old growth stands. The number found besides some species names refers to comments in the appendix. The total number of specimens does not include Aleocharinae.

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Aderidae							
1) *Vanonus calvescens* Casey	-	-	2	-	-	-	-
1) *Vanonus wickhami* Casey	-	6	1	8	5	2	2
Anobiidae							
Caenocara scymnoides LeConte	23	7	4	1	-	2	2
Dorcatoma pallicornis LeConte	12	9	7	-	-	-	-
Ernobius schedli W.J. Brown	-	-	-	-	1	-	3
Hemicoelus umbrosus (Fall)	-	-	1	-	1	1	2
Microbregma e. emarginatum (Duftschmid)	3	5	8	1	-	-	1
Ptilinus pruinosus Casey	1	-	-	-	-	-	-
Ptilinus ruficornis Say	1	-	-	-	1	-	-
Ptinus raptor Sturm	5	2	4	-	-	-	1
Ptinus villiger (Reitter)	-	-	1	-	-	-	-
Stagetus profundus (LeConte)	-	-	-	-	5	-	-
Anthicidae							
Anthicus cervinus LaFerté-Sénectère	-	-	-	-	1	1	-
2) *Ischalia costata* (LeConte)	2	4	72	-	2	20	29
Omonadus floralis (Linné)	-	-	2	-	-	-	-
Artematopidae							
Macropogon piceus LeConte	1	-	-	-	-	-	-
Atellabidae							
Auletobius cassandrae (LeConte)	-	-	1	-	-	1	-
Tmenocerus cyanellus (LeConte)	-	-	1	-	-	-	-
Boridae							
3) *Boros unicolor* Say	-	-	-	3	-	-	-
Brachypteridae							
Heterhelus pennatus (Murray)	-	-	2	-	-	-	-
Brentidae							
4) *Betulapion simile* (Kirby)	4	15	2788	-	-	1	-
Buprestidae							
Agrilus anxius Gory	-	-	1	-	-	-	-
Anthaxia inornata (Randall)	-	-	-	14	2	4	14
Chrysobothris blanchardi Horn	-	-	-	1	1	2	-
Chrysobothris harrisi (Hentz)	-	-	-	-	1	-	1
5) *Chrysobothris neopusilla* Fisher	-	-	-	1	-	1	1
Chrysobothris scabripennis Gory & L. de C.	-	-	-	7	1	-	-
Chrysobothris trinervia (Kirby)	-	-	-	7	-	1	-
Dicerca tenebrica (Kirby)	1	-	-	-	1	-	-
Dicerca tenebrosa (Kirby)	-	-	-	2	-	1	-
Melanophila acuminata (DeGeer)	-	-	-	89	-	-	-
6) *Phaenops abies* Champlain & Knull	-	-	-	-	1	-	2
Phaenops d. drummondi (Kirby)	-	-	-	8	2	-	2
Poecilonota cyanipes (Say)	-	-	1	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Byrrhidae							
Byrrhus geminatus LeConte	-	-	-	20	-	4	-
Cytilus alternatus Erichson	-	-	-	16	1	-	-
Simplocaria semistriata (Fabricius)	1	-	-	-	-	-	-
Cantharidae							
Cantharis curtisi (Kirby)	-	1	1	-	-	-	-
Cantharis impressa (LeConte)	-	-	1	-	-	-	-
Cantharis rufa Linné	2	1	1	-	2	-	-
Malthodes fragilis (LeConte)	23	164	63	-	-	-	-
Malthodes f. fuliginosus LeConte	3	-	4	-	79	2	2
Malthodes niger (LeConte)	12	1	20	-	-	-	-
7) *Malthodes parvulus* (LeConte)	56	29	34	2	30	15	7
Podabrus cf. *puncticollis*	-	-	-	-	4	16	5
Podabrus heteronychus Fall	1	1	-	-	1	1	-
Podabrus intrusus Green	4	-	2	-	-	-	-
Podabrus laevicollis (Kirby)	20	20	60	2	1	1	3
Podabrus limbellus LeConte	-	-	4	-	-	-	-
Podabrus modestus (Say)	1	-	1	-	-	-	-
Podabrus puberulus LeConte	1	-	2	-	1	2	-
Podabrus puncticollis (Kirby)	-	2	-	1	3	2	1
Podabrus sp.	-	-	-	-	1	-	-
Rhagonycha fraxini (Say)	-	-	-	-	-	1	1
Rhagonycha mandibularis (Kirby)	-	1	-	4	22	13	21
Rhagonycha recta (Melsheimer)	1	-	3	1	5	3	-
Rhagonycha sp.	38	80	96	-	-	-	-
Carabidae							
Agonum affine Kirby	-	-	2	-	-	-	-
Agonum gratiosum (Mannerheim)	-	1	9	-	8	3	3
Agonum lutulentum (LeConte)	-	1	-	-	-	-	-
Agonum melanarium Dejean	-	1	1	-	-	1	-
Agonum metallescens (LeConte)	-	-	-	1	-	-	-
8) *Agonum quinquepunctatum* Motschulsky	-	-	-	2	-	-	-
Agonum retractum LeConte	63	7	389	-	1	2	-
Agonum sordens Kirby	1	-	18	1	-	-	-
Amara erratica (Duftschmid)	-	-	3	1	-	1	-
Amara impuncticollis (Say)	-	-	2	-	-	-	-
Amara lunicollis Schiødte	-	-	5	-	-	-	-
Badister obtusus LeConte	-	-	-	-	-	-	1
Bembidion carinula Chaudoir	-	-	1	-	-	-	-
Bembidion concretum Casey	1	-	-	-	-	-	-
Bembidion fortestriatum (Motschulsky)	-	1	3	-	-	-	-
Bembidion grapii Gyllenhal	-	-	1	30	3	-	-
9) *Bembidion obtusum* Audinet-Serville	1	-	-	-	-	-	-
Bembidion wingatei Bland	7	5	-	-	-	-	-
Bradycellus lugubris (LeConte)	1	1	5	-	-	2	-
Bradycellus neglectus (LeConte)	1	-	-	-	1	-	-
Bradycellus nigrinus (Dejean)	-	-	5	-	-	-	-
Bradycellus semipubescens Lindroth	-	-	2	1	1	1	-
Calathus ingratus Dejean	4	13	51	-	12	5	1
Calosoma frigidum Kirby	34	-	1	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Carabus m. maeander Fischer de Waldheim	-	-	-	-	-	1	-
Clivina fossor (Linné)	1	5	3	-	1	1	-
Cymindis cribricollis Dejean	-	-	-	1	1	1	4
Dromius piceus Dejean	-	1	5	1	1	1	12
Dyschirius integer LeConte	-	-	1	-	-	-	-
Elaphrus clairvillei Kirby	-	-	-	-	1	-	-
Harpalus egregius Casey	-	-	-	2	-	-	-
Harpalus nigritarsis C.R. Sahlberg	-	-	1	1	-	-	-
Harpalus solitaris Dejean	1	-	-	1	-	-	-
Lebia fuscata Dejean	-	-	1	-	-	-	-
Lebia moesta LeConte	-	-	-	-	18	-	-
Loricera p. pilicornis (Fabricius)	-	-	1	-	-	-	-
10) *Nomius pygmaeus* Dejean	1	-	1	-	-	-	-
Notiophilus aeneus (Herbst)	1	-	-	-	-	-	-
Patrobus foveocollis (Eschscholtz)	-	-	1	-	-	-	-
Platynus decentis (Say)	156	125	260	-	-	15	7
Platynus mannerheimii (Dejean)	-	-	1	-	-	8	22
Pterostichus adstrictus Eschscholtz	88	110	323	90	6	39	17
Pterostichus coracinus (Newman)	3	23	29	-	-	4	6
Pterostichus luctuosus (Dejean)	-	1	-	-	-	-	-
Pterostichus melanarius (Illiger)	-	-	1	-	1	10	-
Pterostichus pensylvanicus LeConte	136	1	20	1	1	-	-
Pterostichus punctatissimus (Randall)	-	-	87	26	10	90	71
11) *Scaphinotus bilobus* (Say)	5	4	12	2	38	141	64
Sericoda obsoleta (Say)	1	2	2	25	3	3	4
Sericoda quadripunctata (DeGeer)	-	-	-	85	-	5	1
Sphaeroderus nitidicollis brevoorti LeConte	9	3	128	1	2	15	9
Sphaeroderus stenostomus lecontei Dejean	8	7	56	-	-	11	-
12) *Stereocerus haematopus* (Dejean)	-	-	-	-	-	20	2
Syntomus americanus (Dejean)	-	3	-	-	4	-	1
Synuchus impunctatus (Say)	7	5	31	-	3	-	-
Tachyta angulata Casey	1	-	-	16	5	2	8
Trechus apicalis Motschulsky	29	10	64	-	3	3	4
Trechus crassiscapus Lindroth	-	-	1	-	-	3	-
13) *Trechus quadristriatus* (Schrank)	-	-	1	-	-	-	-
Cerambycidae							
Acmaeops p. proteus (Kirby)	1	-	-	26	-	4	2
14) *Acmaeopsoides rufulus* (Haldeman)	-	-	-	-	1	-	-
Arhopalus foveicollis (Halseman)	-	-	-	1	-	-	-
Callidium frigidum Casey	-	-	1	-	-	-	-
Clytus ruricola (Olivier)	11	3	2	-	-	-	-
Evodinus m. monticola (Randall)	-	2	2	-	-	3	1
Gnathacmaeops pratensis (Laicharting)	-	-	-	3	-	-	-
Grammoptera subargentata (Kirby)	1	-	-	-	-	-	-
Judolia m. montivagans (Couper)	-	-	-	-	-	1	1
Judolia quadrata (LeConte)	-	-	-	-	-	-	1
Meriellum proteus (Kirby)	-	-	-	-	-	1	1
Monochamus s. scutellatus (Say)	1	5	4	27	6	22	25
Neoclytus l. leucozonus Gory & Lap. de Cas.	-	-	-	-	1	1	1
Pidonia ruficollis (Say)	4	-	-	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Pogonocherus mixtus Haldeman	-	-	-	1	-	-	-
Pogonocherus penicillatus (LeConte)	-	-	-	-	-	2	9
Pronocera c. collaris (Kirby)	-	-	1	-	-	-	-
Pygoleptura n. nigrella (Say)	-	-	1	2	-	2	1
Rhagium inquisitor (Linné)	-	-	-	3	2	4	4
Stictoleptura c. canadensis (Olivier)	-	-	4	-	1	-	1
Tetropium cinnamopterum Kirby	-	-	1	-	-	1	-
Trachysida aspera brevifrons (H. Howden)	-	-	-	-	-	-	1
Trachysida mutabilis (Newman)	-	1	-	-	-	-	-
15) *Tragosoma depsarium* (Linné)	-	-	-	2	3	-	-
Xestoleptura tibialis (LeConte)	-	4	-	1	6	12	6
Xylotrechus undulatus (Say)	-	-	-	-	-	1	1
Cerylonidae							
Cerylon castaneus Say	4	1	3	-	-	2	-
Cerylon unicolor (Ziegler)	-	1	3	-	-	-	-
Chrysomelidae							
Altica sylvia Malloch	-	-	-	-	69	-	-
Altica corni Woods	2	-	6	2	3	-	-
Altica sp.	-	-	-	-	1	-	-
Bromius obscurus (Linné)	-	-	-	1	-	-	-
Calligrapha alni Schaeffer	-	2	1	-	-	-	-
Capraita subvittata (Horn)	-	-	-	-	-	-	1
Chaetocnema minuta Melsheimer	-	-	-	1	1	-	1
Crepidorera digna Parry	-	-	-	3	2	-	-
Crepidorera populivora Parry	168	5	4	2	24	-	1
Diachus auratus (Fabricius)	-	-	1	-	-	-	-
Diachus catarius (Saffriant)	3	-	-	-	-	-	-
Distigmoptera borealis Blake	-	-	2	1	-	1	1
Longitarsus erro Horn	1	-	-	-	-	-	-
Longitarsus melanurus (Melsheimer)	-	-	-	-	-	1	-
Longitarsus cf. *erro*	1	-	-	-	-	-	-
Longitarsus sp. 1	-	-	-	1	-	-	-
Longitarsus sp. 2	1	-	-	-	-	-	-
Longitarsus sp. 3	-	-	1	-	-	-	-
Longitarsus sp. *luridus* group	1	-	4	2	1	12	4
16) *Neocrepidodera robusta* (LeConte)	-	-	-	-	1	2	-
Pachybrachis nigricornis difficilis Fall	-	-	-	-	17	2	8
Phaedon a. armoraciea (Linné)	-	1	-	-	-	-	-
Phaedon viridis Melsheimer	-	-	2	-	-	-	-
Plateumaris germari (Mannerheim)	-	-	-	1	-	-	-
Plateumaris nitida (Germar)	-	-	-	1	-	-	1
Psylliodes punctulata Melsheimer	-	-	1	-	-	-	-
Syneta extorris borealis W.J. Brown	-	9	13	-	-	6	-
Systena frontalis (Fabricius)	1	-	-	-	-	-	-
Tricholochmaea decora (Say)	-	-	2	-	4	6	3
Tricholochmaea kalmia (Fall)	-	-	-	-	1	-	-
Tricholochmaea vaccinii (Fall)	-	-	2	-	-	-	1
Ciidae							
Ceracis thoracicornis (Ziegler)	1	-	-	-	-	-	-
Cis americanus Mannerheim	-	1	-	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Cis fuscipes Mellié	3	4	1	-	1	-	-
Cis levettei (Casey)	21	192	421	-	-	1	4
Cis pistorius Casey	-	1	1	-	-	-	-
Cis striolatus Casey	-	-	-	-	-	-	2
Dolichocis manitoba Dury	-	7	3	-	-	-	12
Orthocis punctatus (Mellié)	-	-	1	-	-	-	-
Plesiocis cribrum Casey	-	-	-	-	1	-	-
Clambidae							
Clambus a. armadillo (DeGeer)	3	-	5	2	-	1	3
Clambus gibbulus (LeConte)	1	1	1	28	1	8	1
Clambus howdeni Endrödy-Younga	3	98	9	1	2	5	-
Cleridae							
Enoclerus n. nigripes (Say)	-	-	-	26	-	-	-
Phlogistosternus dislocatus (Say)	-	-	-	-	-	1	1
Thanasimus undulatulus (Say)	-	-	-	-	-	-	2
Zenodosus sanguineus (Say)	-	-	1	-	-	-	-
Coccinellidae							
Anatis mali (Say)	-	-	1	-	-	-	-
Calvia quatuordecimguttata (Linné)	10	2	10	-	-	-	-
Chilocorus stigma (Say)	-	1	-	-	-	-	-
Coccidophilus marginatus (LeConte)	-	-	1	1	7	18	4
Coccinella hieroglyphica kirbyi Crotch	-	-	-	-	-	-	1
Coccinella trifasciata perplexa Mulsant	-	-	-	-	1	-	-
Didion nanum (LeConte)	12	2	1	-	5	-	-
17) *Diomus* cf. *arizonicus*	1	-	-	-	-	-	-
Hyperaspis binotata (Say)	1	-	-	-	-	-	-
Hyperaspis consimilis LeConte	-	-	-	1	2	-	-
18) *Hyperaspis inflexa* Casey	-	-	-	-	-	1	-
19) *Hyperaspis moerens* (LeConte)	-	-	1	4	2	1	-
Hyperaspis octavia Casey	-	-	-	-	-	2	-
Microweisea misella (LeConte)	-	-	1	-	10	7	7
Mulsantina hudsonica (Casey)	-	3	9	-	2	5	10
Nephus flavifrons (Melsheimer)	-	-	-	-	1	4	3
20) *Nephus georgei* (Weise)	-	-	1	2	37	18	53
Psyllobora vigintimaculata (Say)	1	-	2	-	-	-	-
Scymnus marginicollis Mannerheim	2	-	-	1	-	-	-
Colydiidae							
Lasconotus borealis Horn	-	1	1	-	-	-	-
Corylophidae							
21) *Clypastraea* cf. *obesa*	1	1	2	43	2	4	2
Clypastraea fasciata (Say)	1	2	4	-	-	-	-
22) *Orthoperus suturalis* LeConte	4	8	42	-	-	2	2
Sericoderus lateralis (Gyllenhal)	1	1	-	-	-	-	-
Cryptophagidae							
23) *Antherophagus ochraceus* Melsheimer	-	-	1	-	-	-	-
Atomaria ephippiata Zimmermann	2	-	1	-	-	-	-
Atomaria ochracea Zimmermann	8	8	15	15	2	54	13
Atomaria sp. 2	7	2	11	21	3	26	24
Atomaria sp. 3	5	3	22	10	5	15	11

TABLE I – continued

		South boreal (mixed boreal)			North boreal (black spruce)			
	Forest types	1	2	3	4	5	6	7
	Atomaria sp. 4	-	-	3	1	1	2	3
	Atomaria sp. 5	1	2	3	-	-	-	-
	Caenoscelis antennalis (Casey)	2	-	1	-	-	-	-
	Caenoscelis basalis Casey	-	1	2	1	-	-	-
24)	*Caenoscelis ferruginea* (C.R. Sahlberg)	13	2	7	4	1	1	2
25)	*Caenoscelis subdeplanata* Brisout	-	-	-	1	1	-	-
	Cryptophagus confertus Casey	1	2	5	2	-	10	8
	Cryptophagus difficilis Casey	-	27	2	1	21	19	2
	Cryptophagus sp. 1	1	1	3	-	9	3	4
	Cryptophagus sp. 2	-	3	4	-	-	-	-
	Cryptophagus sp. 3	-	1	1	-	1	-	-
	Cryptophagus sp. 4	1	-	-	-	-	-	-
	Henoticus serratus (Gyllenhal)	12	7	9	9	6	84	25
	Henotiderus obesulus (Casey)	1	3	4	-	-	2	-
26)	*Myrmedophila americana* (LeConte)	-	-	-	-	-	-	1
	Pteryngium crenatum (Gyllenhal)	-	-	31	-	-	-	-
Cucujidae								
	Pediacus fuscus Erichson	-	-	-	44	1	2	1
Curculionidae: Curculioninae								
	Acalyptus carpini (Herbst)	-	-	-	-	1	-	1
	Anthonomus corvulus LeConte	-	1	-	-	-	-	-
	Anthonomus signatus Say	-	2	-	-	-	-	-
	Anthonomus subfasciatus LeConte	-	-	-	-	2	-	-
	Baris interstitialis (Say)	-	-	1	-	-	-	-
	Carphonotus testaceus Casey	-	3	-	-	-	-	-
	Ceutorhynchus punctiger Gyllenhal	-	-	1	-	-	-	-
	Dorytomus frostii Blatchley	2	-	-	-	1	-	-
	Dorytomus imbecillus Faust	1	-	-	-	-	-	-
	Dorytomus laticollis Casey	1	-	1	-	-	-	-
	Dorytomus mannerheimi (Gemminger)	1	-	-	-	-	-	-
	Dorytomus marmoreus Casey	12	1	-	-	-	-	-
	Grypus equiseti (Fabricius)	-	-	1	-	-	-	-
27)	*Hylobius congener* Dalla Tore et al.	4	10	19	364	2	10	14
	Hylobius pinicola (Couper)	-	1	3	-	2	6	1
	Isochnus populicola (Silfverberg)	4	3	12	-	4	7	5
	Magdalis allutacea LeConte	-	-	-	-	-	1	-
	Magdalis piceae Buchanan	-	1	-	1	-	-	-
	Otiorhynchus ovatus (Linné)	1	1	-	-	-	-	-
	Piazorhinus scuttellaris (Say)	1	2	54	-	-	-	-
	Pissodes fiskei Hopkins	-	-	3	-	-	8	5
	Pseudanthonomus validus Dietz	-	-	14	-	-	-	-
	Rhynchaenus pallicornis (Say)	1	-	4	-	-	-	-
	Rhyncolus brunneus Mannerheim	-	5	2	-	2	4	1
	Sciaphilus asperatus Bonsdorff	1	-	1	-	-	-	-
	Sitona flavescens (Marsham)	1	-	1	-	-	-	-
	Sitona lineellus (Bonsdorff)	-	-	1	-	-	-	-
	Tachyerges ephippiatus (Say)	5	2	-	-	1	-	-
	Tanysphyrus lemnae (Fabricius)	-	-	1	-	-	-	-
Curculionidae: Scolytinae								
	Cryphalus r. ruficollis Hopkins	-	-	-	-	-	1	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Crypturgus borealis Swaine	-	-	1	8	3	26	30
Dryocoetes affaber (Mannerheim)	-	2	1	1	-	1	-
Dryocoetes autographus (Ratzeburg)	-	12	6	38	-	6	21
Dryocoetes betulae Hopkins	-	1	-	-	-	-	-
Ips borealis Swaine	-	1	-	-	-	-	-
Ips latidens (LeConte)	-	-	-	-	-	1	3
Lymantor decepiens (LeConte)	-	-	1	-	-	-	-
Orthomicus caelatus (Eichoff)	-	-	-	1	-	-	-
Phloeosinus canadensis Swaine	-	-	11	-	-	-	-
28) *Phloeotribus piceae* Swaine	-	-	2	-	1	1	-
Pityokteines sparsus (LeConte)	-	-	1	-	-	1	-
29) *Pityophthorus m. murrayanae* Blackman	-	1	-	-	-	3	3
30) *Pityophthorus opaculus* LeConte	-	2	6	3	2	38	61
Pityophthorus p. pulchellus Eischhoff	-	-	-	-	-	1	-
31) *Pityophthorus ramiperda* Swaine	-	-	-	-	-	-	1
Pityophthorus sp.	1	-	-	1	-	-	-
Polygraphus rufipennis (Kirby)	-	2	5	1	-	3	1
Scolytus piceae (Swaine)	-	-	-	-	-	1	1
Trypodendron lineatum (Olivier)	-	1	31	-	-	1	1
Dytiscidae							
Agabus opacus Aubé	-	-	1	-	-	-	-
Agabus thomsoni (J. Salhberg)	-	-	-	1	4	9	10
Hydrocolus stagnalis Gemminger & Harrold	-	-	4	-	-	-	-
Ilybius biguttulus (Germar)	-	-	-	-	-	-	1
Laccornis conoideus (LeConte)	-	-	-	1	-	-	-
Liodessus affinis (Say)	-	-	1	-	-	-	-
Neoscutopterus angustus (LeConte)	-	-	-	1	3	1	3
Rhantus binotatus (Harris)	-	-	-	-	1	-	-
Elateridae							
Agriotes fucosus (LeConte)	10	-	-	-	-	-	-
Agriotes limosus (LeConte)	-	-	1	4	1	1	-
Ampedus apicatus (Say)	-	-	1	-	-	-	-
Ampedus deletus (LeConte)	2	13	9	-	2	5	-
Ampedus fusculus (LeConte)	1	1	5	-	-	2	-
Ampedus laurentinus W.J. Brown	-	-	1	-	-	-	1
Ampedus luctuosus (LeConte)	1	5	10	2	2	22	19
Ampedus nigrinus (Herbst)	3	7	6	1	1	27	20
Ampedus pullus Germar	-	-	-	6	3	1	1
Ampedus quebecensis W.J. Brown	-	-	-	3	2	-	2
Athous rufifrons (Randall)	-	1	2	-	-	-	-
Ctenicera apressa (Randall)	3	-	16	-	-	-	-
Ctenicera falsifica (LeConte)	1	26	4	-	-	-	-
Ctenicera hieroglyphica (Say)	4	-	-	-	-	-	-
Ctenicera insidiosa (LeConte)	-	4	5	-	-	-	-
32) *Ctenicera mendax* (LeConte)	-	-	1	-	-	-	-
Ctenicera nigricolis (Bland)	-	1	-	-	-	-	-
Ctenicera nitidula (LeConte)	2	19	12	-	-	-	-
Ctenicera ochreipennis (LeConte)	-	-	-	-	-	1	-
Ctenicera p. propola (LeConte)	7	9	7	-	-	-	-
Ctenicera replendens aeraria (Randall)	3	-	4	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Ctenicera spinosa (Randall)	3	15	28	-	1	17	-
Ctenicera triundulata (Randall)	2	19	40	1	4	37	35
32) *Ctenicera watsoni* (W.J. Brown)	-	-	-	-	-	2	-
Dalopius cognatus W.J. Brown	27	3	36	-	-	1	-
Dalopius fuscipes W.J. Brown	-	-	1	-	-	-	-
Dalopius vagus W.J. Brown	-	-	2	-	-	-	-
Danosoma brevicorne (LeConte)	-	-	-	1	-	-	-
Denticollis denticornis (Kirby)	1	-	14	-	-	1	1
Eanus decoratus (Mannerheim)	-	2	-	-	-	1	-
Eanus estriatus (LeConte)	-	-	1	2	4	37	33
Eanus maculipennis LeConte	-	-	1	-	-	-	-
Hypnoidus abbreviatus (Say)	-	-	1	1	-	-	-
Hypnoidus impressicollis (Mannerheim)	-	-	-	-	-	1	1
Idiotarmon debilis LeConte	-	2	3	-	-	8	5
Limonius aeger LeConte	-	3	9	-	-	-	-
Limonius pectoralis LeConte	-	-	-	1	-	-	-
Melanotus castanipes (Paykull)	5	2	5	-	-	-	-
Neohypdonus tumescens (LeConte)	1	2	4	1	2	1	1
Sericus honestus (Randall)	-	-	-	4	-	-	-
Sericus incongruus (LeConte)	-	1	1	7	6	10	20
Endomychidae							
Lycoperdina ferruginea LeConte	-	5	11	-	4	-	-
Mycetina perpulchra (Newman)	1	6	5	-	1	14	11
Phymaphora pulchella Newman	-	-	3	-	-	-	-
Erotylidae							
Triplax thoracica Say	1	-	1	-	-	-	-
Tritoma pulchra Say	-	1	-	-	-	-	-
Eucinetidae							
Eucinetus haemorrhoidalis (Germar)	1	-	1	-	1	2	2
Eucinetus morio LeConte	-	2	6	-	-	-	2
33) *Eucinetus oviformis* LeConte	-	-	-	-	-	2	2
Eucinetus punctulatus LeConte	-	-	1	-	-	1	-
Eucinetus testaceus LeConte	-	5	4	-	2	4	7
Eucnemidae							
Epiphanis cornutus Eschsholtz	3	2	-	-	-	5	7
Isorhipis obliqua (Say)	2	-	-	-	-	-	-
Microrhagus subsinuatus (LeConte)	6	6	1	-	-	-	-
Histeridae							
Gnathoncus barbatus Bousquet & Laplante	-	-	1	-	1	5	2
Hister furtivus J.E. LeConte	6	7	16	-	3	14	6
Margarinotus egregius (Casey)	2	-	-	-	-	-	-
Margarinotus faedatus J.E. LeConte	4	-	-	-	-	-	-
Paromalus teres LeConte	-	-	-	1	-	-	-
Platysoma leconti Marseul	-	-	-	1	-	-	-
Hydraenidae							
Hydraena angulicollis Notman	-	-	14	-	-	-	2
Hydraena pensylvanica Kiesenwetter	-	1	5	-	-	-	-
Hydrophilidae							
Cercyon analis (Paykull)	1	-	-	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Cercyon assecla Smetana	849	331	726	1	-	38	9
Cercyon minusculus Melsheimer	1	1	1	-	2	9	4
Cercyon pygmaeus (Illiger)	1	-	-	-	-	-	-
Cretinis digesta (LeConte)	-	-	15	-	-	-	-
Cryptopleurum minutum (Fabricius)	12	2	1	-	-	-	-
Cryptopleurum subtile Sharp	-	-	2	-	-	1	-
Cymbiodyta vindicata Fall	-	-	3	-	1	-	-
Helophorus sempervarians Angus	-	-	1	6	1	7	-
Hydrobius fuscipes (Linné)	1	-	-	-	-	-	1
Paracymus subcupreus (Say)	-	-	-	-	-	-	1
Sphaeridium lunatum Fabricius	-	-	1	-	-	-	-
Laemophloeidae							
Laemophloeus biguttatus (Say)	-	-	-	-	-	2	-
Lampyridae							
Ellychnia corrusca (Linné)	129	82	353	3	9	22	23
Photinus obscurellus LeConte	-	-	1	-	-	-	-
Pyractomena borealis (Randall)	4	2	3	-	-	-	-
Latridiidae							
Cartodere constricta (Gyllenhal)	55	28	170	48	8	36	6
Corticaria sp. 3	5	13	32	759	40	515	264
Corticaria sp. 4	3	2	17	472	7	53	27
Corticaria sp. 5	-	1	-	-	-	-	1
Corticaria sp. 6	-	-	-	-	-	1	-
Corticaria sp. 7	-	-	2	-	-	-	1
Corticaria sp. 9	-	1	4	3	1	40	15
Corticaria sp. 12	-	1	3	1	1	4	1
Corticaria sp. 16	-	-	3	-	2	4	1
Corticarina sp. 11	8	1	4	2	3	2	1
Corticarina sp. 14	-	1	2	-	-	1	-
Cortilena picta (LeConte)	-	-	1	-	-	-	-
Cortinicara sp. 2	192	25	293	12	3	24	21
Enicmus fictus Fall	-	1	7	-	-	-	-
Enicmus tenuicornis LeConte	2	7	10	1	5	49	37
Latridius sp. 1	9	4	25	1	2	46	14
Latridius sp. 2	2	-	-	-	-	-	-
Melanophtalma sp. 1	52	19	93	7	10	37	17
Melanophtalma sp. 8	5	4	21	5	2	7	6
Melanophtalma sp. 10	7	3	11	-	-	32	14
Melanophtalma sp. 15	-	-	-	-	-	1	-
Stephostethus breviclavis (Fall)	1	1	2	-	-	-	1
Stephostethus liratus (LeConte)	11	1	7	-	-	-	-
Leiodidae							
Agathidium cf. *aristerium*	1	2	10	-	-	2	1
Agathidium cf. *difformis*	3	3	14	-	3	7	13
Agathidium cf. *exiguum*	6	1	5	2	14	5	11
Agathidium cf. *parvulum*	1	3	6	-	2	2	1
Agathidium cf. *politum*	-	-	30	-	-	1	-
Agathidium cf. *repentium*	3	-	2	-	2	1	2
Agathidium cf. *temporale*	-	5	22	-	1	28	10
34) *Agathidium pulchrum* LeConte	-	-	4	-	-	1	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Agathidium sp. 1	-	-	1	-	1	-	-
Agathidium sp. 2	2	-	1	-	-	-	-
Anisotoma amica W. J. Brown	-	2	-	-	-	4	1
Anisotoma basalis (LeConte)	4	10	6	-	-	-	3
Anisotoma errans W.J. Brown	3	28	18	1	1	2	4
Anisotoma geminata (Horn)	12	20	43	-	18	62	61
Anisotoma globososa Hatch	-	2	-	14	1	21	32
Anisotoma horni Wheeler	3	27	28	-	2	11	9
Anisotoma inops W.J. Brown	-	11	20	-	1	5	5
Anogdus potens W.J. Brown	-	-	-	1	1	1	-
Catops americanus Hatch	-	4	270	-	1	18	18
Catops basilaris Say	24	44	103	4	19	198	86
Catops gratiosus (Blanchard)	-	9	5	-	-	6	5
Catops luridipennis Mannerheim	-	-	-	-	6	9	15
Catops simplex Say	1	10	6	-	5	27	10
Colenis impunctata LeConte	12	9	3	-	-	1	-
Colon asperatum Horn	-	1	1	-	-	-	-
Colon boreale Peck & Stephan	-	-	30	2	-	2	-
Colon dentatum LeConte	1	-	-	-	-	-	-
Colon forceps Hatch	1	4	12	1	1	-	2
Colon horni Szymczawski	-	-	13	-	-	-	-
Colon magnicolle Mannerheim	-	1	15	1	2	8	3
Colon rectum Hatch	-	-	2	-	-	-	-
35) *Colon similare* Peck & Stephan	-	-	21	-	2	3	-
Hydnobius substriatus LeConte	5	2	78	-	2	-	-
Leiodes assimilis (LeConte)	7	21	33	1	23	4	7
Leiodes collaris (LeConte)	-	1	-	-	-	-	-
Leiodes impersonata Brown	-	-	2	-	-	1	2
Leiodes puncticollis (Thompson)	2	7	184	2	8	11	20
Leiodes punctostriata Kirby	3	1	130	-	1	2	2
Leiodes subtilicornis Baranowski	-	-	-	-	-	1	-
Leiodes valida (Horn)	-	-	-	2	-	-	-
Sciodrepoides fumatus terminans (LeConte)	1	1	4	-	1	2	1
Sciodrepoides watsoni hornianus (Blanchard)	2	9	18	-	3	12	10
Lycidae							
Dictyoptera aurora (Herbst)	1	3	18	4	8	21	5
Leptoceletes basalis (LeConte)	2	25	22	-	29	48	102
Plateros lictor (Newman)	-	-	-	25	89	77	229
Lymexylidae							
36) *Elateroides lugubris* (Say)	7	1	35	-	-	-	-
Megalopodidae							
Zeugophora varians Crotch	-	2	-	-	-	-	-
Melandryidae							
Dircaea liturata (LeConte)	-	3	2	-	-	1	-
Emmesa connectens Newman	1	14	4	-	-	-	-
Enchodes sericea (Haldeman)	1	-	-	-	-	-	-
Orchesia castanea (Melsheimer)	-	-	2	-	1	-	-
Orchesia cultriformis Laliberté	-	1	1	-	1	1	2
Orchesia ovata Laliberté	1	-	10	-	1	-	-
Prothalpia undata LeConte	-	-	1	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Scotochroa buprestoides (Kirby)	-	6	2	1	6	12	6
Serropalpus coxalis Mank	1	1	-	-	-	-	-
Serropalpus substriatus Haldeman	-	1	-	-	-	-	-
Xylita laevigata (Hellenius)	-	-	-	-	-	3	-
Zilora hispida LeConte	-	1	-	-	-	-	-
Melyridae							
Attalus nigrellus (LeConte)	-	-	-	-	1	6	4
37) *Attalus terminalis* Erichson	-	1	-	-	-	-	-
Hoppingiana hudsonica (LeConte)	-	-	-	1	1	3	4
Malachius flavilabrus (Say)	-	-	1	-	-	-	-
Monotomidae							
Monotoma longicollis (Gyllenhal)	1	-	3	2	-	1	-
38) *Rhizophagus b. brunneus* Horn	-	-	2	3	-	-	2
Rhizophagus dimidiatus Mannerheim	5	4	57	-	-	-	1
Rhizophagus minutus rotundicollis Bousquet	-	1	-	-	-	-	-
39) *Rhizophagus pseudobrunneus* Bousquet	-	1	1	-	-	3	1
Rhizophagus remotus LeConte	2	5	3	-	2	3	4
Mordellidae							
Mordellaria borealis (LeConte)	-	3	-	241	150	67	377
40) *Mordellistena andreae ancilla* LeConte	1	-	-	-	-	-	-
Mordellistena errans Fall	-	1	-	-	-	-	-
Mordellistena nigricans Melsheimer	-	-	1	-	-	1	-
Mordellistena scapularis (Say)	-	-	2	-	-	-	-
Mycetophagidae							
Mycetophagus flexuosus Say	-	-	-	-	-	1	-
Mycetophagus pluripunctatus LeConte	-	1	-	-	-	-	-
41) *Thrimolus minutus* Casey	-	-	1	-	-	-	-
Typhaea decipiens Lohse	-	-	-	1	-	-	-
Nemonychidae							
Cimberis pallipennis (Blatchley)	-	10	2	-	-	-	-
Nitidulidae							
Carpophilus marginellus Motschulsky	-	-	-	-	-	1	-
Colopterus truncatus (Randall)	1	2	-	-	2	-	1
Epurea eastiva (Linné)	4	-	10	-	2	-	-
Epurea flavomaculata Mäklin	1	-	-	-	-	-	-
Epurea labilis Erichson	17	3	6	4	-	2	2
Epurea linearis Mäklin	2	1	5	-	-	-	1
Epurea parsoni Connell	45	20	3	1	1	14	10
Epurea peltoides Horn	-	-	-	2	2	-	1
Epurea planulata Erichson	14	13	38	20	1	42	16
Epurea sp.	23	4	8	-	-	6	2
Epurea terminalis Mannerheim	384	132	318	41	22	145	88
Epurea truncatella Mannerheim	5	8	39	6	6	55	59
Glischrochilus confluentus Mannerheim	4	3	33	2	1	10	1
Glischrochilus quadrisignatus (Say)	32	12	53	73	39	172	52
Glischrochilus s. sanguinolenus (Olivier)	29	15	96	-	-	4	5
Meligethes simplipes Easton	-	-	2	1	-	2	-
Omosita discoidea (Fabricius)	1	-	2	-	2	6	1
Thalycra concolor (LeConte)	-	-	1	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Orsodacnidae							
Orsodacne atra (Ahrens)	21	14	5	-	-	-	-
Phalacridae							
Acylomus pugetanius Casey	-	-	1	-	-	-	-
Litochropus scalptus Casey	-	-	1	-	-	-	-
Psephenidae							
Ectopria nervosa (Melsheimer)	-	1	-	-	-	1	-
Ptiliidae (42)							
43) *Acrotrichis castanea* Matthews	1	1	22	19	125	792	433
Acrotrichis cf. *haldemani*	846	76	82	-	-	9	1
44) *Acrotrichis cognata* (Matthews)	1445	253	388	-	21	182	77
45) *Acrotrichis longipennis* Casey	109	136	541	-	2	76	3
46) *Acrotrichis silvatica* Rosskothen	119	50	64	3	128	761	573
47) *Acrotrichis volans* (Motschulsky)	1150	139	219	-	1	18	12
48) *Cylindroselloides dybasi* Hall	-	5	954	-	-	3	1
49) *Micridium* sp. 3	2	3	20	-	3	8	9
Nephanes sp. 1	151	32	71	-	2	95	27
50) *Ptenidium nitidum* (Heer)	-	-	2	-	-	-	-
Ptenidium pusillum (Gyllenhal)	-	-	0	-	-	1	-
51) *Ptenidium speculifer* Matthews	6	-	26	-	-	3	7
52) *Pteryx* n.sp. cf. sp. 2	1	-	2	-	4	6	15
Pteryx sp. 2	14	20	137	1	50	32	36
Pteryx sp. 3	-	-	17	1	6	14	14
Pteryx sp. 10	15	9	194	-	1	28	20
53) *Ptiliola kunzei* (Heer)	1	-	2	1	9	9	4
Ptiliola sp. 1	-	-	1	-	-	-	-
54) *Ptiliolum fuscum* (Erichson)	342	76	85	1	52	440	271
Ptiliolum sp. 2	473	669	819	6	119	377	246
Ptiliolum sp. 8	2	-	117	-	-	1	2
Ptiliopycna moerens (Matthews)	-	-	1	-	-	-	-
55) *Ptinella aptera* (Guérin-Méneville)	51	28	38	-	2	39	55
Ptinella cf. *errabunda*	-	-	-	-	1	-	1
Ptinella cf. *limbata*	-	3	1	-	-	2	-
56) *Ptinella johnsoni* Rutanen	-	-	3	-	4	4	8
Ptilodactylidae							
Ptilodactyla serricollis (Say)	5	2	1	-	1	2	2
Pyrochroidae							
Dendroides canadensis Latreille	1	-	3	-	-	-	-
Dendroides concolor (Newman)	2	2	18	-	-	-	-
Dendroides testaceus LeConte	15	1	1	-	-	-	-
Schizotus cervicalis Newman	1	8	3	-	-	-	-
Pythidae							
Priognathus monilicornis (Randall)	-	-	-	-	2	-	-
Pytho niger Kirby	-	-	-	-	-	1	-
Salpingidae							
Rhinosimus viridiaeneus Randall	-	1	2	-	-	-	-
57) *Sphaeriestes virescens* (LeConte)	-	-	-	117	-	3	-
Scarabaeidae							
Aphodius fimetarius (Linné)	2	-	4	-	-	1	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Aphodius leopardus Horn	-	1	3	-	-	5	-
Aphodius rubripennis Horn	-	1	-	-	-	-	-
Aphodius ruricola Melsheimer	1	4	2	-	-	2	1
Dialytes striatulus (Say)	4	3	5	-	-	-	-
Geotrupes balyi JeKel	2	-	-	-	-	-	-
Phyllophaga anxia (LeConte)	-	-	-	-	-	-	1
Trichiotinus assimilis (Kirby)	-	-	1	-	-	-	-
Scirtidae							
Cyphon modestus (LeConte)	23	3	355	19	26	26	3
Cyphon nebulosus (LeConte)	2	-	12	3	4	8	-
Cyphon obscurus Guérin-Méneville	14	2	2	-	-	3	1
Cyphon ochreatus Klausnitser	-	-	-	12	21	57	14
58) *Cyphon pusillus* (LeConte)	-	-	6	-	1	-	-
Cyphon sp.	11	2	297	30	20	21	15
Cyphon variabilis (Thunberg)	37	1	54	12	15	18	4
Prionocyphon discoideus (Say)	1	-	4	-	-	-	-
Scraptiidae							
Anaspis nigrina Csiki	-	-	-	-	9	5	-
Anaspis rufa Say	43	24	82	1	1	35	12
Canifa pallipes (Melsheimer)	6	7	25	-	1	5	3
Scydmaenidae							
Euconnus sp. 1	1	1	2	2	10	-	6
Euconnus sp. 2	-	-	-	-	1	-	1
Euconnus sp. 3	-	-	1	-	-	-	-
Euconnus sp. 4	-	-	-	-	1	1	-
Microscydmus misellus (LeConte)	3	6	28	-	15	2	20
Stenichnus corpusculus (Casey)	15	14	89	9	27	97	77
Stenichnus sp. 1	1	13	22	-	4	16	10
Stenichnus sp. 2	-	-	2	-	-	4	1
Stenichnus subpunctatus (LeConte)	-	1	1	-	-	-	1
Veraphis sp. 1	1	-	4	1	1	1	3
Veraphis sp. 2	-	-	1	-	-	-	-
Silphidae							
Necrodes surinamensis (Fabricius)	1	-	-	-	-	-	1
Nicrophorus defodiens Mannerheim	223	172	689	1	5	153	38
Nicrophorus investigator Zetterstedt	-	-	-	-	-	1	-
Nicrophorus sayi Laporte de Castelnau	4	14	9	-	-	4	1
Nicrophorus tomentosus Weber	-	1	-	-	-	-	-
Nicrophorus vespilloides Herbst	-	-	2	6	12	56	15
Oiceoptoma noveboracense (Forster)	1	1	-	-	-	-	-
Silvanidae							
Dendrophagus cygnaei Mannerheim	1	-	-	-	-	-	-
Silvanus bidentatus (Fabricius)	4	4	20	11	9	22	17
Sphindidae							
Eurysphindus hirtus LeConte	5	1	3	-	-	-	-
Staphylinidae: Euaesthetinae							
Euaesthetus americanus Erichson	-	1	-	-	1	-	-
Staphylinidae: Habrocerinae							
Habrocerus schwarzi Horn	232	9	11	-	-	28	1

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
Staphylinidae: Micropeplinae							
Micropeplus laticollis Mäklin	-	-	9	-	-	-	-
Staphylinidae: Olisthaerinae							
Olisthaerus substriatus (Gyllenhal)	-	-	-	-	-	-	1
Staphylinidae: Omaliinae							
Acidota crenata (Fabricius)	3	3	13	6	11	21	22
Acidota quadrata (Zetterstedt)	9	7	7	-	1	1	3
Acidota subcarinata Erichson	5	-	58	32	149	50	62
Acrolocha diffusa (Fauvel)	109	4	44	-	-	2	-
Arpedium cribatum Fauvel	-	-	-	-	1	-	-
Boreaphilus henningianus C.R. Salberg	-	-	2	-	1	-	-
59) *Bratinus varicornis* LeConte	7	2	73	-	-	-	-
Eucnecosum brunnescens (J. Sahlberg)	-	-	-	-	-	1	6
Eucnecosum tenue (LeConte)	-	-	-	-	-	1	-
Eusphalerum convexum (Fauvel)	2	-	1	-	1	-	2
Eusphalerum pothos (Mannerheim)	6609	157	7774	-	36	46	16
Hapalaraea humerosa (Fauvel)	-	-	22	-	-	20	14
Hapalaraea longula (Mäklin)	-	-	-	-	-	1	1
Hapalaraea nr. *humerosa*	3	1	3	-	-	-	1
Lesteva pallipes LeConte	2	-	1	-	-	-	-
Olophrum consimile (Gyllenhal)	2	2	12	3	4	2	6
Olophrum rotundicolle (C.R. Sahlberg)	-	-	-	-	1	10	15
Omalium foraminosum Mäklin	7	9	19	-	2	1	1
Omalium nr. *foraminosum*	2	2	2	-	-	-	-
60) *Omalium* sp. d	-	1	1	-	-	2	-
61) *Omalonomus*(?) n.sp.	-	-	1	-	1	-	-
Phloeonomus laesicollis Mäklin	3	6	35	-	1	7	3
Phloeonomus lapponicus (Zetterstedt)	5	4	5	12	10	26	28
Pycnoglypta aptera Campbell	-	7	-	-	1	1	-
Trigonodemus striatus LeConte	-	7	5	-	-	7	2
Staphylinidae: Oxyporinae							
Oxyporus lateralis Gravenhorst	1	2	-	-	-	-	-
Oxyporus quinquemaculatus LeConte	-	9	10	-	-	-	-
Oxyporus rufipennis LeConte	-	-	1	-	-	-	-
62) *Oxyporus vittatus vittatus* Gravenhorst	1	3	-	-	-	-	-
Staphylinidae: Oxytelinae							
63) *Anotylus* nr. *sobrinus*	1	-	-	1	1	-	-
Anotylus rugosus (Fabricius)	-	-	-	1	-	-	1
Apocellus sphaericollis (Say)	-	-	-	-	-	1	2
Bledius annularis LeConte	-	-	-	-	-	1	-
64) *Bledius gravidus* Casey	1	-	-	-	-	-	-
65) *Bledius turgidus* Casey	-	-	-	-	-	-	1
Deleaster dichrous (Gravenhorst)	-	-	1	-	-	-	-
Oxytelus fuscipennis Mannerheim	5	3	4	-	6	34	20
Oxytelus montanus Casey	-	-	-	-	1	-	-
Oxytelus nimius Casey	11	2	18	-	-	-	-
Syntomium grahami Hatch	-	-	3	-	-	-	-
Staphylinidae: Paederinae							
Lathrobium fauveli Duvivier	16	5	97	3	32	60	73

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
66) *Lathrobium fulvipenne* (Gravenhorst)	-	1	2	-	-	-	1
Lathrobium scolopaceum (Casey)	1	1	-	-	1	-	-
Lathrobium simile LeConte	11	2	10	-	-	-	-
Lathrobium washingtoni Casey	17	31	80	-	-	2	1
Lithocharis ochracea (Gravenhorst)	-	-	-	-	-	1	-
Ochthephilum fracticorne (Paykull)	2	2	1	-	3	1	1
Orus dentiger (LeConte)	-	-	-	1	-	-	-
Paederus littorarius Gravenhorst	-	-	-	-	2	-	2
Sunius confluentus (Say)	1	-	1	-	-	-	-
Staphylinidae: Piestinae							
67) *Siagonium stacesmithi* Hatch	-	-	-	-	-	1	-
Staphylinidae: Proteininae							
Megarthrus angulicollis Mäklin	11	1	26	-	15	41	16
Megarthrus excisus LeConte	89	115	85	-	13	104	65
Megarthrus pecki Cuccodoro & Löbl	86	3	3	-	-	-	-
Proteinus atomarius Erichson	4	28	132	-	-	-	1
68) *Proteinus* sp. 5	1	-	1	5	1	1	1
Proteinus sp. 6	-	2	1	4	35	94	109
Proteinus sp. 7	10	8	31	-	-	-	3
Proteinus sp. 8	4	6	7	-	-	-	-
Staphylinidae: Pselaphinae							
69) *Actium* n.sp.	-	-	10	-	-	-	1
70) *Actizona trifoveatum* Park	2	4	1	-	3	1	2
Batrisodes lineaticollis (Aubé)	19	11	17	-	7	17	10
Bibloplectus integer (LeConte)	2	1	8	2	21	15	18
71) *Bibloporus bicanalis* Casey	1	-	-	-	1	1	5
Euplectus confluens LeConte	-	-	-	-	-	-	1
Euplectus duryi Casey	3	7	19	2	46	37	53
72) *Euplectus elongatus* Brendel	-	-	1	2	1	2	1
73) *Euplectus sylvicola* Chandler	-	-	-	-	1	2	1
Lucifotychus hirsutus Chandler	1	2	11	5	11	36	25
Pselaphus bellax Casey	-	1	26	1	59	30	37
Reichenbachia propinqua (LeConte)	3	-	13	-	-	-	-
Reichenbachia spatulifer Casey	2	5	18	14	56	201	227
Rybaxis mystica Casey	-	-	-	-	-	4	-
Rybaxis transversa Fall	-	-	1	-	1	-	-
Tyrus semiruber Casey	-	-	1	-	2	1	4
Staphylinidae: Pseudopsinae							
Pseudopsis sagitta Herman	1	1	1	-	2	36	3
Pseudopsis subulata Herman	151	18	59	-	-	11	1
Pseudopsis n.sp. 1	1	-	-	-	-	-	-
Pseudopsis n.sp. 2	184	26	120	-	1	12	2
Staphylinidae: Scaphidiinae							
Baeocera congener Casey	-	-	1	-	-	-	-
Baeocera deflexa Casey	-	1	14	-	-	-	-
74) *Baeocera humeralis* Fall	5	1	2	-	1	1	2
Scaphisoma convexum Say	-	-	-	6	10	2	14
Scaphisoma rubens Casey	3	1	16	-	-	-	-
Staphylinidae: Staphylininae							
75) *Bisnius blandus* (Gravenhorst)	6	7	9	-	-	-	1

TABLE I – continued

		South boreal (mixed boreal)			North boreal (black spruce)			
	Forest types	1	2	3	4	5	6	7
	Bisnius cephalicus (Casey)	-	-	-	-	1	-	-
76)	*Bisnius pugetensis* (Hatch)	-	1	-	-	-	-	-
	Bisnius siegwaldii (Mannerheim)	4	7	15	-	1	3	2
77)	*Dinothenarus capitatus* Bland	42	31	17	-	-	3	-
	Erichsonius patella (Horn)	-	1	2	1	-	-	-
	Gabrius brevipennis (Horn)	37	92	209	1	-	1	-
78)	*Gabrius lyssipius* Smetana	2	1	15	-	-	-	-
	Gabrius microphtalmus (Horn)	94	107	194	41	45	343	101
	Gabrius picipennis Mäklin	7	3	17	1	-	1	1
	Heterothops fusculus LeConte	-	-	-	4	-	-	1
79)	*Heterothops minor* Smetana	-	-	-	21	3	1	-
80)	*Neobisnius villosulus* (Stephens)	-	-	1	-	-	-	-
	Ontholestes cingulatus (Gravenhorst)	185	28	118	1	6	56	26
	Philonthus caeruleipennis Mannerheim	61	60	42	-	2	103	15
	Philonthus concinnus (Gravenhorst)	-	-	1	-	-	-	-
	Philonthus flavibasis Casey	-	-	-	2	2	1	2
	Philonthus flumineus Casey	2	2	16	-	-	-	-
	Philonthus jurgans Tottenham	-	-	-	-	-	2	1
	Philonthus lindrothi Smetana	-	1	-	-	-	-	-
	Philonthus lomatus Erichson	-	-	-	1	-	-	-
	Philonthus opacipennis Notman	-	-	1	-	-	-	-
	Philonthus politus (Linné)	-	-	1	-	-	-	-
81)	*Philonthus spiniformis* Hatch	-	-	-	3	19	8	19
82)	*Philonthus validus* Casey	-	-	1	-	-	1	3
	Philonthus varians (Paykull)	1	1	-	1	1	3	1
	Quedius brunnipennis Mannerheim	-	-	-	-	1	14	1
	Quedius canadensis (Casey)	15	9	24	-	1	1	1
	Quedius capucinus (Gravenhorst)	24	18	16	1	1	57	14
83)	*Quedius c. caseyi* Scheerpeltz	7	274	35	-	-	-	-
84)	*Quedius frigidus* Smetana	-	1	-	10	8	43	32
	Quedius fulvicollis (Stephens)	-	1	5	-	-	-	-
	Quedius l. labradorensis Smetana	9	2	58	-	11	6	7
	Quedius peregrinus (Gravenhorst)	13	-	-	-	-	-	-
	Quedius plagiatus Mannerheim	3	7	5	1	-	36	5
	Quedius rusticus Smetana	14	16	291	7	8	88	40
85)	*Tympanophorus puncticollis* (Erichson)	-	2	7	-	1	-	-
Staphylinidae: Steninae								
	Stenus austini Casey	8	5	26	2	4	22	16
	Stenus carinicollis Casey	-	2	34	-	-	-	-
	Stenus gratiosus Casey	-	3	-	-	1	5	7
	Stenus mammops Casey	1	1	40	4	6	9	14
	Stenus sibiricus J. Sahlberg	-	7	-	-	-	-	-
Staphylinidae: Tachyporinae								
	Bolitobius sp. 1	3	3	11	-	2	2	3
	Bryophacis smetanai Campbell	12	3	11	-	1	2	2
	Bryoporus rufescens LeConte	5	-	1	-	-	1	-
	Carphacis nipigonensis (Bernhauer)	2	2	1	-	-	2	1
	Ischnosoma fimbrinatum Campbell	1	3	5	3	10	12	27
	Ischnosoma pictum (Horn)	26	4	130	-	8	3	8
	Ischnosoma splendidum (Gravenhorst)	-	-	29	-	4	2	7

TABLE I – continued

		South boreal (mixed boreal)			North boreal (black spruce)			
	Forest types	1	2	3	4	5	6	7
86)	*Ischnosoma virginiense* (Bernhauer)	-	-	-	1	-	-	-
87)	*Lordithon appalachianus* Campbell	3	7	28	-	-	-	2
88)	*Lordithon facilis* (Casey)	3	11	3	-	-	-	-
	Lordithon fungicola Campbell	131	209	99	3	23	291	258
89)	*Lordithon longiceps* (LeConte)	-	-	-	-	-	-	1
90)	*Lordithon quaesitor* (Horn)	-	5	11	-	-	-	-
	Lordithon scutellaris Campbell	3	-	74	-	-	1	-
	Lordithon t. thoracicus (Fabricius)	3	2	5	3	4	3	6
	Mycetoporus americanus Erichson	-	-	72	1	3	4	4
	Mycetoporus consors LeConte	13	20	13	-	1	-	-
	Mycetoporus horni Bernhauer & Schubert	-	-	14	-	1	1	-
	Sepedophilus littoreus (Linné)	5	2	28	2	14	22	15
91)	*Sepedophilus occultus* (Casey)	-	1	4	-	-	-	-
	Tachinus addendus Horn	165	40	312	-	-	17	5
	Tachinus basalis Erichson	57	58	25	-	9	74	56
	Tachinus elongatus Gyllenhal	-	-	13	-	-	-	-
	Tachinus frigidus Erichson	-	-	2	-	1	60	18
	Tachinus fumipennis (Say)	769	709	749	-	-	163	8
	Tachinus horni Campbell	-	2	1	-	-	-	-
	Tachinus luridus Erichson	209	173	223	-	3	44	23
	Tachinus memnonius Gravenhorst	-	2	1	-	-	-	-
	Tachinus picipes Erichson	8	2	28	-	-	1	-
	Tachinus quebecensis Robert	3	17	38	-	-	3	2
92)	*Tachinus schwarzi* Horn	-	-	1	-	-	-	-
	Tachinus tachyporoides Horn	-	1	1	-	-	-	-
93)	*Tachinus vergatus* Campbell	-	3	5	-	-	-	-
	Tachyporus borealis Campbell	3	-	38	-	3	2	-
94)	*Tachyporus dispar* (Paykull)	7	-	2	-	2	-	2
	Tachyporus nitidulus (Fabricius)	123	23	3	-	5	4	2
Staphylinidae: Trichophyinae								
	Trichophya pilicornis (Gyllenhal)	1	2	2	47	14	89	24
Staphylinidae: Xantholininae								
	Atrecus americanus (Casey)	2	2	3	-	-	-	-
	Atrecus macrocephalus (Nordmann)	-	1	10	-	6	28	17
	Nudobius cephalus (Say)	2	-	4	2	-	1	4
Stenotrachelidae								
	Cephaloon ungulare LeConte	-	-	1	-	-	-	-
Tenebrionidae								
	Bolitotherus cornutus (Panzer)	4	4	9	-	-	-	-
	Eleates depressus (Randall)	-	-	2	-	-	-	-
	Hymenorus pilosus (Melsheimer)	-	-	1	-	-	-	-
	Isomira quadristriata (Couper)	20	9	23	-	2	-	-
	Paratenetus fuscus LeConte	-	1	10	-	-	-	-
	Scaphidema aeneolum (LeConte)	-	1	-	-	-	-	-
	Upis ceramboides (Linné)	1	4	2	-	-	-	-
Tetratomidae								
	Hallomenus punctulatus LeConte	-	-	-	-	-	-	1
	Hallomenus serricornis LeConte	-	-	-	-	1	-	-
	Penthe obliquata (Fabricius)	-	1	-	-	-	-	-
	Penthe pimelia (Fabricius)	-	-	2	-	-	-	-

TABLE I – continued

	South boreal (mixed boreal)			North boreal (black spruce)			
Forest types	1	2	3	4	5	6	7
95) *Tetratoma concolor* LeConte	-	-	-	-	-	-	1
Throscidae							
Trixagus carinicollis (Schaeffer)	14	6	12	2	7	2	1
Trogossitidae							
Thymalus marginicollis Chevrolat	4	-	-	-	-	-	1
Zopheridae							
Phellopsis obcordata (Kirby)	-	-	6	-	-	-	-
Total	18233	6743	27433	3534	2738	9383	6491
Grand total	74555						

Discussion and conclusions

The present data provides a list of beetles associated with seven forest habitats that are characteristic of the eastern boreal forest of Canada. A good proportion of the records represent either extension ranges, new records (provincial, Canadian and North American) or simply show interesting ecological information despite that comments were kept to a minimum. This suggests that our previous knowledge of this portion of the boreal forest was inadequate.

The results also show that Staphylinidae are the major group in terms of species richness and abundance. Although some other families, such as Carabidae and Leiodidae, have been the focus of ecological studies, the importance of Staphylinidae support their potential use as bioindicators. This question is, however, fully addressed in Paquin and Dupérré (unpublished data) which compare the potential of all families as bio-indicators of forest types.

While phytophagy is thought to explain a large part of the evolutionary success of beetles (Farrell 1998), these trophic habits only represent 13% (including phytophages and xylophages on living trees) of the species collected in this study. This small proportion in regard to the other trophic guilds suggests that forest beetle diversity is more related to decaying processes (saprophages, xylophages) than on living plant material. Dead wood has been pointed out as a key factor for many forest organisms (Harmon et al. 1986). The high proportion of mycophagous beetles for which dead wood is an obligatory substrate for many fungus also supports this.

Finally, it is striking to see that many species are still undescribed or unidentifiable at present and therefore relying on morphospecies number to be included in diversity studies. While some families are well known taxonomically, Latridiidae, Cryptophagidae, Scydmaenidae and Ptiliidae are inadequately known, despite their richness and potential as bioindicators.

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APPENDIX. Comments on new records, distribution and ecological observations. Numbers refer to Table I.

1) *Vanonus calvescens*, *Vanonus wickhami.* Based on Werner (1990), these two records are the northernmost for the species. Most specimens were collected with flight-interception and Malaise traps.

> ***Vanonus calvescens*: Abitibi-ouest: Lake Duparquet:** (48°49'30"N; 79°19'30"W) in white cedar/balsam fir forest beating vegetation (1) 22.vii.1997

> ***Vanonus wickhami*: Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) in mature black spruce forest Malaise/FIT pan (1) 27.vii-03.viii.1997

2) *Ischalia costata.* The records from the black spruce succession extend the distribution of the species by about 100 km to the north (Young 1975). The northernmost record is given here.

> **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) in mature black spruce forest pitfall (1) 15-22.vi.1997

3) *Boros unicolor.* Hand collecting in burned forests yielded several specimens, both adults and larvae, found under bark of burned black spruce (*Picea mariana* Mill. B.S.P.) and jackpine (*Pinus banksiana* Lamb.). Young et al. (1996) report similar observations for *Lecontia discicollis,* the only other species of the family Boridae in North America.

4) *Betulapion simile.* This species feeds on birch flowers (Bright 1993), but we collected it in high numbers in emergence cages. This suggests a possible pupation in the soil.

5) *Chrysobothris neopusilla* is a rare species according to Bright (1987). Three specimens were collected in black spruce forests.

> **Jamésie (Baie James):** (49°44'35"N; 79°02'10"W) in burned growth black spruce forest flight-interception trap (1) 22-29.vi.1997 • (49°48'16"N; 78°51'20"W) in old growth black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°33'26"N; 79°18'56"W) in mature black spruce forest flight-interception trap (1) 21-29.ix.1997

6) *Phaenops abies* is a rare species according to Bright (1987). Three specimens were collected in black spruce forests.

> **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) in old growth black spruce forest flight-interception trap (1) 29.vi-06.vii.1997 • (1) 06-13.vii.1997 • (49°48'23"N; 78°52'47"W) in regenerating black spruce forest flight-interception trap (1) 06-13.vii.1997

7) *Malthodes parvulus.* A total of 173 specimens were collected almost exclusively in emergence cages. All are female. This is surprising because a methodological bias for females is hardly possible with emergence cages. This suggest a parthenogenetic reproduction, but it still remains to be formally established.

8) *Agonum quinquepunctatum* was known in Quebec from two northern localities: Fort Georges and Poste-de-la-Baleine (Larochelle 1975). The present collections extend the distribution of the species to the south by about 500 km. Interestingly, both specimens were collected in burned forests.

> **Jamésie (Baie James):** (49°44'35"N; 79°02'10"W) in burned growth black spruce forest pitfall (1) 24-31.viii.1997 • (49°48'56"N; 78°55'06"W) in burned black spruce forest pitfall (1) 05-12.x.1997

9) *Bembidion obtusum* is an introduced species in North America (Bousquet and Larochelle 1993). The species was known from southern Quebec (Hoebeke et al. 1991) and the present record is a northern extension by about 600 km. Yves Bousquet identified the specimen.

> **Abitibi-ouest: Lake Duparquet:** (48°29'50"N; 79°16'25"W) in deciduous forest Malaise/FIT pan (1) 11-18.ix.1994

10) *Nomius pygmaeus* is rarely collected and these records confirm its presence at the edge of its northern limit. Yves Bousquet confirmed the identification.

> **Abitibi-ouest: Lake Duparquet:** (48°29'50"N; 79°16'25"W) in deciduous forest Berlese sample of mosses of dead log (1) 03.viii.1997 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Berlese sample of bark of dead balsam fir (1) 24.vii.1990

11) *Scaphinotus bilobus.* According to Lindroth (1961), it is a rare species but a total of 256 specimens were collected in mature and old growth black spruce forests.

12) *Stereocerus haematopus* is a tundra species according to Lindroth (1966). Larochelle (1975) records it from high latitudes in the province and from the top of Mount Albert in the Gaspé Park, which harbours similar climatic conditions (see LeSage and Paquin 2001). The records reported here from black spruce forest do not fit the known ecological scheme of the species. The present collections suggest wider habitat selection flexibility than previously suspected. A cryptic species is also a possibility (H. Goulet, pers. comm.), but there is no evidence yet that this is the case.

> **Jamésie (Baie James):** (49°36'23"N; 79°18'03"W) pitfall in mature black spruce forest (3) 06-15.vi.1997 • (1) 15.vi.1997 • (3) 15-22.vi.1997 • (4) 22-29.vi.1997 • (2) 29.vi-06.vii.1997 • (1) 06-13.vii.1997 • (2) 20-27.vii.1997 • (1) 27.vii-03.viii-1997 • (1) 03-10.viii-1997 • (1) 24-31.viii-1997 • (49°37'54"N; 79°17'58"W) flight-interception trap in mature black spruce forest (1) 15-22.vi.1997 • (49°50'01"N; 78°41'12"W) flight-interception trap in old growth black spruce forest (2) 13-20.vii.1997

13) *Trechus quadristriatus* was first reported in North America by Bousquet et al. (1984). The species was known from the Great Lakes region in Ontario. It was later reported from Quebec by Bousquet (1991b) and Bousquet and Larochelle (1993), but no indication about the localities was given. The present record is believed to extend its known distribution by about 600 km to the north. Yves Bousquet identified the specimen.

> **Abitibi-ouest: Lake Duparquet:** (48°19'30"N; 79°19'30"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 18-25.viii.1996

14) *Acmaeopsoides rufula* is a rare species according to Yanega (1996). It occurs in the Great Lakes area and in the St. Lawrence River drainage. The specimen collected in the black spruce forest increases its distribution range and broadens its known habitat.

> **Jamésie (Baie James):** (49°43'35"N; 79°17'59"W) flight-interception trap in regenerating black spruce forest (1) 06-15.vi.1997

15) *Tragosoma depsarium*. In Scandinavia, the species is considered as a typical primeval species by Biström and Väisänen (1988). The collections reported here, however, suggests its association with younger regeneration stages, especially in recently burned areas, where dead wood is also abundant.

16) *Neocrepidodera robusta* is a widespread species (LeSage 1991) but rarely collected. It is found mainly in northern latitudes and the host plant is still unknown (L. LeSage, pers. comm.).

> **Jamésie (Baie James):** (49°48'54"N; 78°43'23"W) flight-interception trap in regenerating black spruce forest (1) 15-22.vi.1997 • (49°05'26"N; 79°08'54"W) in mature black spruce forest flight-interception trap (1) 15-22.vi.1997 • pitfall (1) 15-22.vi.1997

17) *Diomus* cf. *arizonicus*. This undescribed species is superficially similar to *Scymnus kansanus* Casey, which is known from a single record from Montreal (Larochelle 1979b). The discovery of such species is questioning the accuracy of the *S. kansanus* record in the province. N. Vandenberg kindly provided her opinion the specimens' identity.

> **Abitibi-ouest: Lake Duparquet:** (48°29'50"N; 79°16'25"W) Malaise/FIT top in deciduous forest (1) 12-19.vi.1994

18) *Hyperaspis inflexa*. This specimen shows a color pattern which is closer to *Hyperaspis dissoluta dissoluta* Crotch — restricted in Canada to the west coast (McNamara 1991a) — than the elytral pattern shown for *H. inflexa* in Gordon (1985). According to N. Vandenberg (pers. comm. 2001), another *H. inflexa* showing the same pattern is known from Nominingue, but such a variation was not reported in Gordon (1985). N. Vandenberg identified the specimen and kindly provided valuable information.

> **Jamésie (Baie James):** (49°05'26"N; 79°08'54"W) flight-interception trap in mature black spruce forest (1) 15-22.vi.1997

19) *Hyperaspis moerens* was first reported in Quebec by Chantal (1990) from two localities in Saguenay. The present records confirm the presence of this rare species in Quebec.

> **Abitibi-ouest: Lake Duparquet:** (48°19'30"N; 79°19'30"W) emergence cage top in white cedar/balsam fir forest (1) 12-19.vi.1994 • **Jamésie (Baie James):** (49°48'56"N; 78°55'06"W) flight-interception trap in burned black spruce forest (1) 06-15.vi.1997 • (49°48'56"N; 78°55'06"W) flight-interception trap in burned black spruce forest (1) 15-22.vi.1997 • (49°43'35"N; 79°17'59"W) flight-interception trap in regenerating black spruce forest (1) 22-29.vi.1997 • (49°44'35"N; 79°02'10"W) pitfall in burned growth black spruce

> forest (1) 22-29.vi.1997 • (49°48'23"N; 78°52'47"W) flight-interception trap in regenerating black spruce forest (1) 20-27.vii.1997 • (49°44'35"N; 79°02'10"W) flight-interception trap in burned growth black spruce forest (1) 03-10.viii.1997 • (49°49'03"N; 79°00'06"W) Berlese sample of mosses of dead black spruce in mature black spruce forest (1) 04.vii.1997

20) *Nephus georgei.* See Paquin and Dupérré (2000a) for details about these records.

21) *Clypastraea* cf. *obesa* fits Casey's original description but the distribution of the species in the western part of the continent raises a doubt about its presence in northeastern North America. We prefer to wait until a formal revision of the genus before certifying its identity.

22) *Orthoperus suturalis*, **new provincial record**. The 58 specimens were mainly collected by Berlese extractions of dead conifer bark and polypores. Despite the known association of adults of this species with polypore fungi, many specimens were either collected in soil samples or emergence cages, thus suggesting that pupation occurs in the soil.

> **Abitibi-ouest: Lake Duparquet:** (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample of bark of dead balsam fir (2) 13.vi.1997 • Berlese sample of polypores on dead birch (1) 13.vi.1997 • Berlese sample of bark of dead balsam fir and striped polypores (2) 22.ix.1997 • Berlese sample of polypores on conifers (2) 26.vii.1996 • Berlese sample of birch bark (1) 19.ix.1996 • Berlese sample of polypore on balsam fir (1) 19.ix.1996 • Berlese sample of polypore on birch (4) 19.ix.1996 • Berlese sample of polypore on balsam fir bark (1) 16.x.1996 • emergence cage pan (1) 05-12.vi.1994 • Malaise/FIT pan (1) 05-12.vi.1994 • (1) 12-19.vi.1994 • pitfall (1) 30.vi-07.vii.1994 • (1) 14-21.vii.1994 • soil sample (2) 05.vi.1994 • (48°29'32"N; 79°14'28"W) in mixed forest Berlese sample of polypores on dead birch (1) 13.vi.1997 • Berlese sample of dead birch bark (1) 13.vi.1997 • Berlese sample of polypores on dead birch (3) 22.vii.1997 • emergence cage pan (1) 29.v-05.vi.1994 • Malaise/FIT pan (1) 29.v-05.vi.1994 • soil sample (1) 26.vi-03.vii.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest Berlese sample of polypores on dead birch (2) 13.vi.1997 • Berlese sample of polypores on dead aspen (1) 13.vi.1997 • emergence cage top (1) 29.v-05.vi.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Berlese sample of polypores on birch (2) 09-18.ix.1996 • Berlese sample of polypores on dead birch (18) 24.vii.1996 • Berlese sample of polypores on dead birch (1) 18.ix.1996 • sifting litter (1) 15.vi.1996 • **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) flight-interception trap in old growth black spruce forest (1) 13-20.vii.1997 • (49°32'41"N; 79°19'00"W) Malaise/FIT pan in old growth black spruce forest (1) 13-20.vii.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest Malaise/FIT pan (1) 06-15.vi.1997 • (1) 20-27.vii.1997

23) *Antherophagus ochraceus.* According to Leschen (1996), the species is associated with *Bombus* nests.

> **Abitibi-ouest: Lake Duparquet:** (48°19'30"N; 79°19'30"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 14-21.vii.1994

24) *Caenoscelis ferruginea*, **new provincial record**. According to Bousquet (1991c), this species was known only from Alaska and British Columbia. The present records are the first ones from the east coast of the continent. Colin Johnson kindly identified our specimens.

> **Abitibi-ouest: Lake Duparquet:** (48°29'50"N; 79°16'25"W) in deciduous forest • Emerging cage pan (1) 03-10.vii.1994 • (1) 17-24.vii.1994 • (1) 07-14.viii.1994 • Malaise/FIT pan (1) 17-24.vii.1994 • (3) 24-31.vii.1994 • (2) 31.vii-07.viii.1994 • (2) 07-14.viii.1994 • (1) 11-18.ix.1994 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 28-03.ix.1994 • Berlese extraction of rotten log (1) 22.viii.1997 • (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest • Emerging cage pan (1) 10-17.vii.1994 • (1) 28-03.ix.1994 • pitfall (1) 21-29.vii.1996 • (1) 29.vii-04.viii.1996 • (1) 25.viii-01.ix.1996 • (1) 25.viii-01.ix.1996 • Canopy funnel (1) 18-25.viii.1996 • **Jamésie (Baie James):** (49°50'01"N; 78°41'12"W) in old growth black spruce forest flight-interception trap (1) 10-17.viii.1997 • (49°05'26"N; 79°08'54"W) in regenerating black spruce forest flight-interception trap (1) 27.vii-03.viii.1997 • (49°44'35"N; 79°10'06"W) in burned black spruce forest pitfall (1) 17-24.viii.1997 • (49°48'56"N; 78°55'06"W) in burned black spruce forest pitfall (1) 20-27.vii.1997 • (1) 24-31.viii.1997 • flight-interception trap (1) 27.vii-03.viii.1997 • (49°48'23"N; 78°52'47"W) in regenerating black spruce forest pitfall (1) 03-10.viii.1997 • (49°32'41"N; 79°19'00"W) in old growth black spruce pitfall (1) 20-27.vii.1997 • Malaise/FIT pan (1) 10-17.viii.1997.

25) *Caenoscelis subdeplanata*, **new Canadian record**. The species was known from North America (Johnson 1993), but only from unpublished records in Canada (C. Johnson, *in litt.*). Colin Johnson kindly identified our specimens and provided useful information about its distribution.

Jamésie (Baie James): (49°44'35"N; 70°00'06"W) in burned black spruce forest flight-interception trap (1) 27.vii-03.viii.1997 • (49°49'03"N; 78°41'12"W) sifting forest litter in mature black spruce forest (1) 04.vii.1997.

26) *Myrmedophila americana.* According to Bousquet (1989), the species is associated with *Formica* nests. Yves Bousquet kindly confirmed the identification.

Jamésie (Baie James): (49°35'06"N; 79°17'51"W) flight-interception trap in old growth black spruce forest (1) 27.vii-03.viii.1997

27) *Hylobius congener* was found in high number in recently burned black spruce stands. Interestingly, congeneric species were also reported from burned forests in Poland by Szujecki (1987) which suggests affinities of some members of the genus for this peculiar habitat.

28) *Phloeotribus piceae.* The records of this rarely collected species confirm its northern distribution (Bright 1976). All specimens were collected with Malaise and flight interception traps.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 23.v-02.vi.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 09-16.vi.1996 • **Jamésie (Baie James):** (49°48'23"N; 78°52'47"W) flight-interception trap in regenerating black spruce forest (1) 06-15.vi.1997 • (49°01'50"N; 79°08'47"W) flight-interception trap in mature black spruce forest (1) 31.viii-07.ix.1997

29) *Pithyophthorus murrayanae murrayanae*, **new provincial record**. According to Bright (1981) and McNamara (1991b), the species was previously known from Ontario and Nova Scotia only. Don Bright identified our specimens.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) Malaise/FIT pan in mixed forest (1) 12-19.vi.1994 • **Jamésie (Baie James):** (49°29'36"N; 79°17'53"W) flight-interception trap in old growth black spruce forest (1) 06-15.vi.1997 • (49°51'13"N; 78°38'59"W) flight-interception trap in old growth black spruce forest (1) 22-29.vi.1997 • (49°01'50"N; 79°08'47"W) flight-interception trap in mature black spruce forest (1) 29.vi-06.viii.1997 • (49°44'35"N; 79°02'10"W) pitfall in burned growth black spruce forest (1) 06-13.vii.1997 • (49°32'41"N; 79°19'00"W) flight-interception trap in old growth black spruce forest (1) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) flight-interception trap in mature black spruce forest (1) 21-28.ix.1997

30) *Pithyophthorus opaculus.* These records extend the distribution range of the species in Quebec by nearly 600 km to the north west (Bright 1981).

Jamésie (Baie James): (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 31.viii-07.ix.1997

31) *Pithyophthorus ramiperda.* These records extend the distribution range of the species in Quebec by nearly 600 km to the north west (Bright 1981).

Jamésie (Baie James): (49°35'06"N; 79°17'51"W) flight-interception trap in old growth black spruce forest (1) 06-15.vi.1997

32) *Ctenicera mendax* and *Ctenicera watsoni* are rarely collected species. These records confirm their occurrence in Quebec and their affinities with the boreal forest. Serge Laplante identified the specimens.

***Ctenicera mendax*:** **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 09-16.vi.1996

***Ctenicera watsoni*:** **Jamésie (Baie James):** (49°37'54"N; 79°17'58"W) flight-interception trap in mature black spruce forest (1) 06-15.vi.1997 • (49°49'03"N; 79°00'06"W) flight-interception trap in mature black spruce forest (1) 22-29.vi.1997

33) *Eucinetus oviformis.* Lévesque and Lévesque (1993) first reported the occurrence of the species in Quebec from Johnville near Sherbrooke. The records from the boreal forest extend its known distribution of about 680 km to the north.

Jamésie (Baie James): (49°32'41"N; 79°19'00"W) flight-interception trap in old growth black spruce forest (1) 21-28.ix.1997 • (49°36'23"N; 79°18'03"W) flight-interception trap in mature black spruce forest (1) 29.vi-06.vii.1997 • (49°33'26"N; 79°18'56"W) flight-interception trap in mature black spruce forest (1)

06-13.vii.1997 • (49°50'01"N; 78°41'12"W) flight-interception trap in old growth black spruce forest (1) 13-20.vii.1997

34) *Agathidium pulchrum,* **confirmation.** The species was included in the Quebec species list of Larochelle (1979a) but was excluded from Laplante et al. (1991) because the identity of most species belonging to the genus *Agathidium* could not be certified. The genus is still in need of revision and species in the list are therefore designated with 'cf.' except for *A. pulchrum* which was certified by Q. Wheeler.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) emergence cage pan in white cedar/balsam fir forest (1) 09-19.vi.1994 • (48°29'50"N; 79°16'25"W) Berlese sample of rotten log in deciduous forest (1) 22.vii.1994 • **Témiscamingue: Lake Labyrinthe:** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 07-14.vii.1996 • (1) 14-21.vii.1996 • **Jamésie (Baie James)**: (49°33'31"N; 78°59'02"W) flight-interception trap in mature black spruce forest (1) 06-15.vi.1997

35) *Colon similare*, **new provincial record**. Based on distribution given in Peck and Stephan (1996), the present records are the first reported in Quebec. A few specimens were collected with Malaise traps but some were found in emergence cages, supporting the hypothesis that immature stages of the genus *Colon* feed on hypogean fungi or at least pupate in the soil.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) canopy funnel in white cedar/balsam fir forest (1) 21-29.vii.1996 • **Témiscamingue: Lake Labyrinthe**: (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest emergence cage top (1) 29.vii-04.viii.1996 • emergence cage top (2) 04-11.viii.1996 • (1) 25.viii-01.ix.1996 • emergence cage pan (2) 08-15.ix.1996 • Malaise/FIT pan (2) 04-11.viii.1996 • (5) 25.viii-01.ix.1996 • (2) 01-08.ix.1996 • (2) 08-15.ix.1996 • (1) 22-29.ix.1996 • **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 03-10.viii.1997 • (49°33'26"N; 79°18'56"W) flight-interception trap in mature black spruce forest (1) 06-13.vii.1997 • (49°33'26"N; 79°18'56"W) flight-interception trap in mature black spruce forest (1) 27.vii-03.viii.1997 • (49°48'23"N; 78°52'47"W) flight-interception trap in regenerating black spruce forest (1) 17-24.viii.1997 • (49°49'03"N; 79°00'06"W) Berlese sample of dead black spruce log in mature black spruce forest (1) 04.vii.1997

36) *Elateroides lugubris* is a peculiar beetle that is rarely seen. We have collected 43 specimens in the southern succession with Malaise traps. This species shows striking color variations, a phenomena also reported by Wheeler (1986) for *E. dermestoides,* a Eurasian species.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (3) 29.v-05.vi.1994 • (1) 05-12.vi.1994 • (14) 12-19.vi.1994 • (2) 02-09.vi.1996 • (48°29'32"N; 79°14'28"W) Malaise/FIT pan in mixed forest (1) 12-19.vi.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest Malaise/FIT pan (3) 05-12.vi.1994 • (4) 12-19.vi.1994 • **Témiscamingue: Lake Labyrinthe**: (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT top (1) 23.v-02.vi.1996 • (1) 02-09.vi.1996 • (2) 09-16.vi.1996 • Malaise/FIT pan (3) 23.v-02.vi.1996 • (3) 02-09.vi.1996 • (5) 09-16.vi.1996

37) *Attalus terminalis,* **confirmation.** The species was known from Canada but these records were overlooked by Bright (1991) in the Canadian checklist and by Laplante et al. (1991) in the Quebec list. The present record confirms the presence of the species in Quebec.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT top (1) 31.vii-07.viii.1994

38) *Rhizophagus*. Interestingly, many specimens of *Rhizophagus* were collected with the canopy-funnel technique, suggesting that adults may be associated with the upper canopy of the forest.

39) *Rhizophagus pseudobrunneus*, **new provincial record**. According to Bousquet (1990), this species occurs mainly on the West Coast, except from an isolated record in Manitoba. The present record from Quebec extends its known distribution by about 1600 km to the east. Yves Bousquet kindly confirmed the identification.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) Malaise/FIT pan in mixed forest (1) 19-26.vi.1994 • (48°19'30"N; 79°19'30"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 10-17.vii.1994 • **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 13-20.vii.1997 • (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) flight-interception trap in mature black spruce forest (1) 03-10.viii.1997 • (49°35'06"N; 79°17'51"W) flight-interception trap in old growth black spruce forest (1) 24-31.viii.1997

40) *Mordellistena andreae ancilla*, **new provincial record**. According to Liljeblad (1945), the black ventral coloration is characteristic of that subspecies.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) Malaise/FIT top in mixed forest (1) 21-28.viii.1994

41) *Thrimolus minutus*. The specimen collected on an immature *Fomitopsis pinicola* (Fr.) Karst (Polyporaceae), is the second record for Canada. The species was previously known only from a single damaged specimen. The present record extends its known distribution by about 630 km to the north. This rare species reaches as far south as Texas and Florida and nothing is known about its biology (Young, *in press*).

Témiscamingue: Lake Labyrinthe: (48°13'35"N; 79°27'47"W) Berlese extraction of small immature *Fomitopsis pinicola* (Polyporaceae*)* in white cedar/balsam fir forest (1) 24.vii.1996

42) In North America, Ptiliidae are most probably the beetle family which is taxonomically least known. Consequently, many species from Canada are still undescribed despite their abundance and peculiar life habits. The morphotype numbers indicated in the list refer to the code numbers used by M. Sörensson, a world authority of the family, who kindly identified representative specimens from our samples. Hopefully, future revisions will associate these code numbers with species name and our ecological information will not be lost. New records are based on Laplante et al. (1991) and Campbell (1991b). Recently, Sörensson (*in press)* made an important contribution to the knowledge of North American Ptiliidae, reporting many new records and distribution data.

43) *Acrotrichis castanea*, **new provincial record**. A total of 374 samples contained this species which are too numerous to list. The following record is the northernmost from our samples. Sörensson (*in press*) provides additional distribution data for the species.

Jamésie (Baie James): (49°49'03"N; 79°00'06"W) flight-interception trap in mature black spruce forest (8) 06-15.vi.1997

44) *Acrotrichis cognata,* **new provincial record**. A total of 205 samples contained this species which are too numerous to list. The following record is the northernmost of our samples. Sörensson (*in press*) provides additional distribution data on this introduced species.

Jamésie (Baie James): (49°51'13"N; 78°38'59"W) flight-interception trap in mature black spruce forest (1) 03-10.viii.1997

45) *Acrotrichis longipennis,* **new Canadian record.** A total of 206 samples contained this species. These are too numerous to list. Almost all specimens were collected in the southern part of the boreal forest, but the following record, which is the northernmost for the species from our samples, comes from the black spruce area. Sörensson (*in press*) provides additional distribution data.

Jamésie (Baie James): (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 13-20.vii.1997

46) *Acrotrichis silvatica,* **new North American record.** A total of 347 samples contained this species which are too numerous to list. The following record is the northernmost from our samples. Sörensson (*in press*) provides additional distribution data for the species.

Jamésie (Baie James): (49°51'13"N; 78°38'59"W) flight-interception trap in mature black spruce forest (1) 07-14.ix.1997

47) *Acrotrichis volans*, **new provincial record.** A total of 134 samples contained this species which are too numerous to list. The following record is the northernmost from our samples. Sörensson (*in press*) provides additional distribution data for the species.

Jamésie (Baie James): (49°51'13"N; 78°38'59"W) flight-interception trap in mature black spruce forest (1) 03-10.viii.1997

48) *Cylindroselloides dybasi*. See Paquin and Dupérré (2000b) for details about these records.

49) *Micridium*. According to Campbell (1991b), this is the first record of the genus in Canada.

50) *Ptenidium nitidum*, **new provincial record**. Sörensson (*in press*) provides additional distribution data for the species.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) Berlese sample of mosses in white cedar/balsam fir forest (1) 19.ix.1996 • **Témiscamingue: Lake Labyrinthe**: (48°13'35"N; 79°27'47"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 30.vi-07.vii.1996

51) *Ptenidium speculifer,* **new Canadian record**. Sörensson (*in press*) provides additional distribution data for the species.

> **Abitibi-ouest: Lake Duparquet** (48°29'50"N; 79°16'25"W) in deciduous forest emergence cage pan (1) 28.viii-03.ix.1994 Malaise/FIT pan (1) 18-25.ix.1994 • (1) 14-21.viii.1996 • (1) 03-10.vii.1996 • (1) 10-17.vii.1996 • (1) 17-24.vii.1996 • (48°29'32"N; 79°14'28"W) in mixed forest emergence cage pan (1) 03-10.vii.1996 • Malaise/FIT pan (1) 17-24.vii.1996 • (2) 10-17.vii.1996 • (3) 03-10.vii.1996 • (1) 19-26.vi.1996 • (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample fungi on of dead aspen bark (1) 21.viii.1996 • emergence cage pan (1) 29.vii-04.viii.1996 • Malaise/FIT pan (1) 21-29.vii.1996 • (1) 14-21.viii.1996 • (4) 24-31.vii.1996 • (4) 17-24.vii.1996 • (9) 10-17.vii.1996 • (4) 03-10.vii.1996 • **Jamésie (Baie James):** (49°33'31"N; 78°59'02"W) mature black spruce forest flight-interception trap (1) 14-21.xi.1997 • (1) 13-20.vii.1997 • (49°29'36"N; 79°17'53"W) old growth black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°32'41"N; 79°19'00"W) old growth black spruce forest (2) 13-20.vii.1997 • Malaise/FIT pan (4) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) mature black spruce forest (1) 27.vii-03.viii.1997

52) *Pteryx*. According to Campbell (1991b), these are the first records of the genus in Canada.

53) *Ptiliola kunzei,* **new North American record**. Sörensson (*in press*) provides additional distribution data for the species.

> **Abitibi-ouest: Lake Duparquet** (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample of mosses on dead log (1) 12-19.vi.1994 • Malaise/FIT pan (1) 31.vii-07.viii.1996 • (48°29'50"N; 79°16'25"W) in deciduous forest Malaise/FIT pan (1) 29.v-05.vi.1994 • **Jamésie (Baie James):** (49°43'35"N; 79°17'59"W) flight-interception trap regenerating black spruce forest (1) 31.viii-07.ix.1997 • (49°37'54"N; 79°17'58"W) mature black spruce forest (1) 27.vii-03.viii.1997 • (49°36'23"N; 79°18'03"W) mature black spruce forest (1) 17-24.viii.1997 • (49°35'37"N; 79°17'46"W) old growth black spruce forest (1) 17-24.viii.1997 • (1) 20-27.vii.1997 • (49°32'41"N; 79°19'00"W) old growth black spruce forest Malaise/FIT pan (1) 24-31.viii.1997 • (1) 29.ix-05.x.1997 • (49°05'26"N; 79°08'54"W) flight-interception trap mature black spruce forest (1) 10-17.viii.1997 • (49°01'50"N; 79°08'47"W) mature black spruce forest (1) 24-31.viii.1997 • (49°48'23"N; 78°52'47"W) regenerating black spruce forest (1) 03-10.viii.1997 • (1) 27.vii-03.viii.1997 • (2) 20-27.vii.1997 • Malaise/FIT pan (2) 20-27.vii.1997 • (2) 06-15.vi.1997 • (49°48'56"N; 78°55'06"W) flight-interception trap burned black spruce forest (1) 03-10.viii.1997 • (49°49'03"N; 79°00'06"W) mature black spruce forest (1) 24-31.viii.1997 • (2) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) Malaise/FIT pan mature black spruce forest (1) 06-15.vi.1997 • (1) 20-27.vii.1997

54) *Ptiliolum fuscum,* **new North American record**. A total of 280 samples contained this species which are too numerous to list. The following record is the northernmost from our samples. Sörensson (*in press*) provides additional distribution data for the species.

> **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) flight-interception trap old growth black spruce forest, (1), 07-14.ix.1997

55) *Ptinella aptera,* **new North American record**. A total of 128 samples contained this species which are too numerous to list. The following record is the northernmost from our samples. Sörensson (*in press*) provides additional distribution data for the species.

> **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) flight-interception trap old growth black spruce forest, (1), 07-14.ix.1997

56) *Ptinella johnsoni,* **new North American record**. Sörensson (*in press*) provides additional distribution data for the species.

> **Abitibi-ouest: Lake Duparquet** (48°19'30"N; 79°19'30"W) white cedar/balsam fir forest cage emergence pan in (1) 14-21.vii.1996 • Malaise/FIT pan (1) 14-21.viii.1994 • (1) 10-17.vii.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 14-21.vii.1996 • **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) old growth black spruce forest flight-interception trap (1) 24-31.viii.1997 • (49°43'35"N; 79°17'59"W) regenerating black spruce forest flight-interception trap (1) 20-27.vii.1997 • (1) 13-20.vii.1997 • (49°35'06"N; 79°17'51"W) old growth black spruce forest flight-interception trap (1) 06-13.vii.1997 • (49°33'26"N; 79°18'56"W) mature black spruce forest flight-interception trap (2) 20-27.vii.1997 • (49°35'06"N; 79°17'51"W) old growth black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°32'41"N; 79°19'00"W) old growth black spruce forest flight-interception trap (1) 20-27.vii.1997 • (1) 13-20.vii.1997 • (1) 06-13.vii.1997 •

Malaise/FIT pan (1) 20-27.vii.1997 • (49°05'26"N; 79°08'54"W) mature black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°50'01"N; 78°41'12"W) old growth black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°48'54"N; 78°43'23"W) regenerating black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°48'23"N; 78°52'47"W) regenerating black spruce forest flight-interception trap (1) 06-13.vii.1997 • (49°49'03"N; 79°00'06"W) mature black spruce forest flight-interception trap (1) 13-20.vii.1997

57) *Sphaeriestes virescens*. This species was found in high numbers in recently burned black spruce stands. Interestingly, congeneric species were reported from burned forests in Europe by Muona and Rutanen (1994), which suggests affinities of some members of the genus for this peculiar habitat.

58) *Cyphon pusillus*, **new provincial record**. All specimens were collected with Malaise and flight-interception traps.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) Malaise/FIT top in white cedar/balsam fir forest (1) 08-15.ix.1996 • **Témiscamingue: Lake Labyrinthe:** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT top (1) 18-25.viii.1996 • (1) 25.viii-01.ix.1996 • (3) 08-15.ix1996 • **Jamésie (Baie James):** (49°43'35"N; 79°17'59"W) flight-interception trap in regenerating black spruce forest (1) 31.viii-07.ix.1997

59) *Brathinus brevicornis.* The records from the Lake Duparquet area extend the species distribution to its northwest limits of Quebec (Peck 1975). The habitat of the species has been described as cool riparian or swampy-boggy situations, among roots of grass growing near water (Peck 1975; White 1983). The present data, 82 specimens mainly collected with pitfalls in coniferous forest, suggest that the species occurs frequently in the litter, as pointed out by Newton et al. (2000).

60) *Omalium* sp. d. This morphotype indicated in the list refers to the code numbers used for undescribed specimens in the C.N.C. by M. Thayer. Hopefully, future revisions will indicate these code numbers, so that the ecological information will not be lost.

61) *Omalonomus* (?) n.sp. This morphotype represent a species that may be closely related to this monotypic genus (Campbell and Peck 1990; M. Thayer, pers. comm.). The two specimens collected in Quebec differ from *Omalonomus relictus* by being fully pigmented and having functional eyes.

62) *Oxyporus vittatus vittatus*. The records from Lake Duparquet are the northernmost for the species, slightly extending its known distribution in Quebec given in Campbell (1969).

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) Malaise/FIT pan in mixed forest (2) 21-28.viii.1994 • (1) 03-11.ix.1994 • (48°29'50"N; 79°16'25"W) Malaise/FIT pan in deciduous forest (1) 03-11.ix.1994

63) *Anotylus* nr. *sobrinus.* According to Anthony Davies, this undescribed species is close but distinct from *Anotylus sobrinus.*

Jamésie (Baie James): (49°48'23"N; 78°52'47"W) Malaise/FIT pan in regenerating black spruce forest (1) 06-15.vi.1997 • (49°48'56"N; 78°55'06"W) flight-interception trap in burned black spruce forest (1) 06-15.vi.1997

64) *Bledius gravidus,* **new provincial record**. The species was known from the Ottawa area (Herman 1972). The record from Lake Duparquet is the northernmost for the species and extends its known distribution by nearly 600 km in eastern North America. Anthony Davies kindly confirmed this identification.

Abitibi-ouest: Lake Duparquet: (48°29'50"N; 79°16'25"W) Berlese sample of rotten log in deciduous forest (1) 13.vi.1994

65) *Bledius turgidus.* According to the distribution given in Herman (1972), this record is the northernmost in eastern North America.

Jamésie (Baie James): (49°32'41"N; 79°19'00"W) Malaise/FIT pan in old growth black spruce forest (1) 06-15.vi.1997

66) *Lathrobium fulvipenne,* **new provincial record.** This species, introduced from Europe, was previously known from British Columbia and Alberta on the West Coast and Newfoundland on the East Coast (Campbell and Davies 1991). Anthony Davies kindly confirmed our identification.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) Berlese sample of bark of dead birch in mixed forest (1) 13.vi.1997 • (48°19'30"N; 79°19'30"W) Berlese sample of mosses in white cedar/balsam fir forest (1) 13.vi.1997 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) Berlese sample of dead log in white cedar/balsam fir forest (1) 12.vi.1996 • **Jamésie (Baie James):** (49°32'41"N; 79°19'00"W) soil sample in old growth black spruce forest (1) 01.x.1997

67) *Siagonium stacesmithi* was reported from British Columbia and Alberta by Moore (1975) and from Labrador and Quebec by Campbell and Davies (1991). The present record from mature black spruce forest suggests a wide boreal distribution for the species.

Jamésie (Baie James): (49°37'54"N; 79°17'58"W) flight-interception trap in mature black spruce forest (1) 06-15.vi.1997

68) *Proteinus.* The morphotype numbers used here refer to those of dissected specimens found in the Canadian National Collection. Hopefully, these reference numbers will be indicated in the revision of the genus so the present ecological data won't be lost.

69) *Actium* n.sp. This undescribed species, specialized in old growth boreal forest, is the first record of the genus *Actium* in eastern Canada. Another species is known from eastern North America in United States while all other 34 species are restricted to the West Coast (Grigarick and Schuster 1971; Chandler 1997). Donald Chandler kindly offered his expertise for this species.

70) *Actizona trifoveatum* is a rare species. The provincial records for Quebec given in Chandler (1997) are based on the specimens collected in this study.

Abitibi-ouest: Lake Duparquet: (48°29'50"N; 79°16'25"W) in deciduous forest emergence cage top (1) 17-24.vii.1994 • emergence cage pan (1) 17-24.vii.1994 • (48°29'32"N; 79°14'28"W) Berlese sample of rotten log in mixed forest (2) 22.vii.1997 • Berlese sample of birch bark (1) 22.ix.1997 • Malaise/FIT pan (1) 12-19.vi.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) Berlese sample of rotten log in white cedar/balsam fir forest (1) 18.viii.1996 • **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) Malaise/FIT pan in mature black spruce forest (1) 15-22.vi.1997 • (49°32'41"N; 79°19'00"W) pitfall in old growth black spruce forest (1) 06-13.vii.1997 • (49°48'54"N; 78°43'23"W) flight-interception trap in regenerating black spruce forest (1) 06-15.vi.1997 • (49°43'35"N; 79°17'59"W) flight-interception trap in regenerating black spruce forest (1) 06-15.vi.1997 • (49°36'23"N; 79°18'03"W) flight interception trap in mature black spruce forest (1) 22-29.vi.1997 • (49°29'36"N; 79°17'53"W) flight-interception trap in old growth black spruce forest (1)13-20.vii.1997

71) *Bibloporus bicanalis* is a rare species (Newton et al. 2000). Chandler (1987) reported its first collection since the original description by Casey in 1893. The present records are most probably the northernmost for the species.

Abitibi-ouest: Lake Duparquet: (48°29'50"N; 79°16'25"W) Berlese sample of rotten coniferous log in deciduous forest (1) 22.vii.1997 • **Jamésie (Baie James):** (49°05'26"N; 79°08'54"W) Soil sample in mature black spruce forest (1) 14.ix.1997 • (49°43'32"N; 79°02'37"W) pitfall in mature black spruce forest (1) 03-10.viii.1997 • (49°29'36"N; 79°17'53"W) flight-interception trap in old growth black spruce forest (1) 20-27.vii.1997 • (49°48'13"N; 78°54'33"W) pitfall in mature black spruce forest (1) 06-13.viii.1997 • (49°43'35"N; 79°17'59"W) flight-interception trap in regenerating black spruce forest (1) 29.vi-06.vii.1997 • (49°48'16"N; 78°51'20"W) flight-interception trap in old growth spruce forest (1) 29.vi-06.vii.1997 • (49°35'06"N; 79°17'51"W) flight-interception trap in regenerating black spruce forest (1) 15-22.vi.1997

72) *Euplectus elongatus*, **new provincial record**. In Canada, the species was previously known from Ontario only (Chandler 1997). Donald Chandler identified this species.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample of dead balsam fir bark (1) 22.viii.1997 • **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) Berlese sample of rotting black spruce log in mature black spruce forest (1) 04.vii.1997 • (49°48'13"N; 78°54'33"W) flight-interception trap in mature black spruce forest (1) 22-29.vi1997 • (49°48'56"N; 78°55'06"W) flight-interception trap in burned black spruce forest (1) 22-29.vi1997 • (49°29'36"N; 79°17'53"W) flight-interception trap in old growth black spruce forest (1) 27-03.viii.1997 • (49°44'35"N; 79°02'10"W) pitfall trap in burned black spruce forest (1) 03-10.viii.1997 • (49°49'03"N; 79°00'06"W) flight-interception trap in mature black spruce forest (1) 31.viii-07.ix.1997

73) *Euplectus sylvicola*, **new provincial record**. According to Chandler (1997), the species was only known from Nova Scotia and mainly occurs in old growth forests according to Chandler (1987). Donald Chandler kindly identified these specimens.

Jamésie (Baie James): (49°49'03"N; 79°00'06"W) Berlese sample of rotting black spruce log in mature black spruce forest (1) 04.vii.1997 • (49°33'26"N; 79°18'56"W) flight-interception trap in mature black spruce forest (1) 24-31.viii.1997 • (49°37'54"N; 79°17'58"W) flight-interception trap in mature black spruce forest (1) 27.vii-03.viii.1997 • (49°32'41"N; 79°19'00"W) pitfall trap in old growth black spruce forest (1) 06-15.vi.1997

74) *Baeocara humeralis*, **new provincial record**. These records extend the known distribution from New Hampshire and Manitoba to Quebec (Löbl and Stephan 1993).

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest canopy funnel (1) 01-08.ix.1994 • (48°29'32"N; 79°14'28"W) Berlese sample of mosses on log in mixed forest (1) 24-31.vii.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest emergence cage pan (1) 03-11.ix.1994 • Malaise/FIT pan in deciduous forest (1) 12-19.vi.1994 • (1) 07-14.viii.1994 • (1) 14-21.viii.1994 • (1) 03-11.ix.1994 • **Témiscamingue: Lake Labyrinthe**: (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 07-14.vi.1996 • **Jamésie (Baie James):** (49°36'23"N; 79°18'03"W) flight-interception trap in mature black spruce forest (1) 17-24.viii.1997 • (49°35'06"N; 79°17'51"W) flight-interception trap in old growth black spruce forest (1) 07-14.ix.1997 • (49°32'41"N; 79°19'00"W) Malaise/FIT pan in old growth black spruce forest (1) 17-24.viii.1997 • (49°48'23"N; 78°52'47"W) flight-interception trap in regenerating black spruce forest (1) 22-29.vi.1997

75) *Bisnius blandus*, **new provincial record**. The species was previously associated with deciduous forests (Smetana 1995), but the present data suggest that it is also found in coniferous forests. A. Smetana kindly confirmed our identification.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 17-24.vii.1994 • (2) 02-09.vi.1996 • (1) 14-21.vii.1996 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (3) 29.v-05.vi.1994 • (1) 12-19.vi.1994 • (2) 10-17.vii.1994 • (1) 17-24.vii.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest Malaise/FIT pan (1) 12-19.vi.1994 • (4) 03-10.vii.1994 • (1) 10-17.vii.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest) emergence cage pan (1) 09-16.vi.1996 • Malaise/FIT pan (1) 02-09.vi.1996 • (2) 09-16.vi.1996 • pitfall (1) 09-16.vi.1996 • **Jamésie (Baie James):** (49°32'41"N; 79°19'00"W) in old growth black spruce forest Malaise/FIT pan (1) 06-15.vi.1997

76) *Bisnius pugetensis* is associated with gopher nests (Smetana 1995). The present record is an extension of the species range to the western part of Quebec.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 12-19.vi.1994

77) *Dinotherarus capitatus* is a rarely collected species (A. Smetana, pers. comm.). The present records confirm its occurrence in the boreal forest.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 05-12.vi.1994 • (1) 28.viii-03.ix.1994 • (1) 03-11.ix.1994 • (1) 11-18.ix.1994 • (2) 18-25.ix.1994 • (1) 18-25.viii.1996 • (2) 25.viii-01.ix.1996 • (1) 08-15.ix.1996 • (1) 16.iv-15.v.1994 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (2) 21-28.viii.1994 • (1) 03-11.ix.1994 • (3) 11-18.ix.1994 • (5) 18-25.ix.1994 • (1) 25.ix-02.x.1994 • (2) 02-09.x.1994 • pitfall (17) 16.iv-15.v.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest Malaise/FIT pan (2) 07-14.viii.1994 • (1) 14-21.viii.1994 • (3) 21-28.viii.1994 • (4) 03-11.ix.1994 • (13) 11-18.ix.1994 • (7) 18-25.ix.1994 • pitfall (1) 21-28.viii.1994 • (11) 16.iv-15.v.1994 • **Jamésie (Baie James):** (49°37'54"N; 79°17'58"W) in mature black spruce forest flight-interception trap (1) 24-31.viii.1997 • (49°36'23"N; 79°18'03"W) in mature black spruce forest flight-interception trap (1) 24-31.viii.1997 • (1) 31.viii-07.ix.1997 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest canopy-funnel (1) 08-15.ix.1996 • Malaise/FIT pan (1) 23.v-02.vi.1996 • (1) 02-09.vi.1996 • pitfall (1) 09-16.vi.1996 • (1) 18-25.viii.1996 • (1) 25.viii-01.ix.1996

78) The occurrence of *Gabrius lyssipius* in the forest surrounding Lake Duparquet extends its known range from the Gatineau Park by about 600 km to the north (Smetana 1995).

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 19-26.vi.1994

79) *Heterotops minor* was found mainly in the first stages of the black spruce ecological succession; this is the northernmost record for the species in Quebec (Smetana 1971).

Jamésie (Baie James): (49°48'56"N; 78°55'06"W) in burned black spruce forest flight-interception trap (1) 22-29.vi.1997

80) *Neobisnius villosulus* occurrence in the coniferous forest of Lake Duparquet is the northernmost record for this introduced species (Frank 1981; Campbell and Davies 1991).

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) Malaise/FIT pan in white cedar/balsam fir forest (1) 12-19.vi.1994

81) *Philonthus spiniformis,* **new provincial record**. According to distribution data given in Smetana (1995), the present records confirm the occurrence of the species in boreal forest of Quebec. A. Smetana kindly confirmed our identifications.

Jamésie (Baie James): (49°48'23"N; 78°52'47"W) in regenerating black spruce forest Malaise/FIT pan (7) 06-15.vi.1997 • (4) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest (1) 06-13.vii.1997 • (49°51'13"N; 78°38'59"W) in old growth black spruce forest) flight-interception trap (1) 06-15.vi.1997 • (2) 20-27.vii.1997 • (1) 03-10.viii.1997 • (49°50'01"N; 78°41'12"W) in old growth black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°48'23"N; 78°52'47"W) in regenerating black spruce forest flight-interception trap (1) 14-21.ix.1997 • (49°48'13"N; 78°54'33"W) in mature black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°48'56"N; 78°55'06"W) in burned black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°33'31"N; 78°59'02"W) in mature black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°29'36"N; 79°17'53"W) in old growth black spruce forest flight-interception trap (1) 20-27.vii.1997 • (49°43'35"N; 79°17'59"W) in regenerating black spruce forest flight-interception trap (3) 06-15.vi.1997• (1) 29.vi-06.vii.1997 • (1) 17-24.viii.1997 • (1) 24-31.viii.1997 • (1) 07-14.ix.1997 • (49°37'54"N; 79°17'58"W) in mature black spruce forest flight-interception trap (1) 13-20.vii.1997 • (49°35'37"N; 79°17'46"W) in old growth black spruce forest flight-interception trap (2) 06-15.vi.1997 • (1) 13-20.vii.1997 • (2) 20-27.vii.1997 • (1) 27.vii-03.viii.1997 • (1) 03-10.viii.1997 • (49°35'06"N; 79°17'51"W) in old growth black spruce forest flight-interception trap (1) 06-13.vii.1997 • (1) 17-24.viii.1997 • (49°33'26"N; 79°18'56"W) in mature black spruce forest flight-interception trap (1) 06-15.vi.1997 • (49°32'41"N; 79°19'00"W) in old growth black spruce forest flight-interception trap (1) 20-27.vii.1997 • (1) 03-10.viii.1997 • (1) 17-24.viii.1997 • (1) 31.viii-07.ix.1997 • (49°05'26"N; 79°08'54"W) in mature black spruce forest flight-interception trap (1) 24-31.viii.1997 • (49°01'50"N; 79°08'47"W) in mature black spruce forest flight-interception trap (1) 31.viii-07.ix.1997 • (49°44'35"N; 79°02'10"W) in burned growth black spruce forest pitfall (1) 13-20.vii.1997 • (1) 20-27.vii.1997

82) *Philonthus validus* is associated with beaver and muskrat nests (Smetana 1995). The present records are the northernmost for the species in Quebec.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 12-12-19.vi.1994 • **Jamésie (Baie James):** (49°32'41"N; 79°19'00"W) in old growth black spruce forest Malaise/FIT pan (1) 27.vii-03.viii.1997 • (1) 31.viii-07.ix.1997 • (49°51'13"N; 78°38'59"W) in old growth black spruce forest flight-interception trap (1) 24-31.viii.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest Malaise/FIT pan (1) 07-14.ix.1997

83) *Quedius caseyi caseyi,* **new provincial record.** A. Smetana confirmed our identifications.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest • beating (1) 16.x.1996 • emergence cage pan (1) 02-09.x.1994 • (1) 09-16.x.1994 • Malaise/FIT pan (1) 01-08.ix.1996 • (1) 16-23.x.1994 • (1) 18-25.ix.1994 • (1) 18-25.viii.1996 • pitfall (1) 13.x-09.xi.1996 • (1) 25.ix-02.x.1994 • (1) 30.iii-13.iv.1994 • (2) 23.iv-25.v.1994 • (3) 01.ix-08.xii.1993 • (3) 02-09.x.1994 • (3) 09-16.x.1994 • (3) 30.x-10.xii.1994 • (48°29'32"N; 79°14'28"W) in mixed forest Berlese sample of mosses (2) 22.ix.1997 • emergence cage pan (1) 02-09.x.1994 • (73) 02-09.x.1994 • (2) 16-23.x.1994 • (72) 16-23.x.1994 • Malaise/FIT pan (1) 09-16.x.1994 • pitfall (7) 01.ix-08.xii.1993 • (1) 13.iv-23.iv.1994 • (1) 28.viii-03.ix.1994 • (2) 11-18.ix.1994 • (5) 18-25.ix.1994 • (25) 25.ix-02.x.1994 • (32) 09-16.x.1994 • (6) 16-23.x.1994 • (32) 23-30.x.1994 • (1) 13-20.xi.1994 • (14) 30.x-10.xii.1994 • (48°29'50"N; 79°16'25"W) in deciduous forest emergence cage pan (1) 09-16.x.1994 • Malaise/FIT pan (1) 18-25.ix.1994 • pitfall (4) 09-16.x.1994 • (1) 23-30.x.1994 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest emergence cage top (1) 13.x-09.xi.1996 • pitfall (4) 13.x-09.xi.1996

84) *Quedius frigidus,* **new provincial record.** These records represent an important range extension of about 700 km to the north in the eastern part of the continent (see Smetana 1971, 1973, 1976, 1978, 1981, 1990 for details about distribution of the species). A. Smetana confirmed our identifications.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Berlese sample of mosses (1) 22.ix.1994 • **Jamésie (Baie James):** (49°51'13"N; 78°38'59"W) in old growth black spruce forest) pitfall (2) 13-20.vii.1997 • soil sample (1) 01.x.1997 • (1) 14.ix.1997 • (49°50'01"N; 78°41'12"W) in old growth black spruce forest pitfall (1) 06-13.vii.1997 • (1) 20-27.vii.1997 • (2) 22-29.vi.1997 • (1) 01.x.1997 • (49°48'54"N; 78°43'23"W) in regenerating black spruce forest pitfall (1) 13-20.vii.1997 • soil sample (1) 14.ix.1997 • (49°48'16"N; 78°51'20"W) in old growth black spruce forest pitfall (1) 20-27.vii.1997 • (1) 22-29.vi.1997 • soil sample (1) 14.ix.1997 • (49°48'23"N; 78°52'47"W) in regenerating black spruce forest flight-interception trap (1) 06-15.vi.1997 • pitfall (1) 20-27.vii.1997 • (1) 27.vii-03.viii.1997 • (3) 20-27.vii.1997 • (49°48'13"N; 78°54'33"W) in mature black spruce forest pitfall (1) 03-10.viii.1997 • (1) 06-13.vii.1997 • (1) 22-29.vi.1997 • (2) 20-27.vii.1997 • (6) 01.x.1997 • (49°48'56"N; 78°55'06"W) in burned black spruce forest flight-interception trap (1) 06-13.vii.1997 • pitfall (1) 06-15.vi.1997 • (1) 13-20.vii.1997 • (1) 29.vi-06.vii.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest Berlese sample of mosses (1) 04.vii.1997 • (1) 04.viii.1997 • (1) 09.ix.1997 • (1) 10.x.1997• flight-interception trap (2) 24-31.viii.1997 • Malaise/FIT pan (1) 17-24.viii.1997 • (2) 07-14.ix.1997 • pitfall(1) 22-29.vi.1997 • soil sample (1) 14.ix.1997 • (49°43'32"N; 79°02'37"W) in old growth spruce forest pitfall (1) 29.vi-06.vii.1997 • soil sample (1) 14.ix.1997 • (3) 01.x.1997• (49°33'31"N; 78°59'02"W) in mature black spruce forest flight-interception trap (1) 24-31.viii.1997 • (49°43'35"N; 79°17'59"W) in regenerating black spruce forest flight-interception trap (1) 06-15.vi.1997 • soil sample (1) 17.viii.1997 • (49°37'54"N; 79°17'58"W) in mature black spruce forest pitfall (1) 03-10.viii.1997 • (1) 06-15.vi.1997 • (1) 20-27.vii.1997 • (1) 22-29.vi.1997 • (2) 24-31.viii.1997 • soil sample (1) 15.vi.1996 • (49°36'23"N; 79°18'03"W) in mature black spruce forest pitfall (1) 06-13.vii.1997 • (1) 20-27.vii.1997 • soil sample (1) 17.viii.1997 • (49°35'37"N; 79°17'46"W) in old growth black spruce forest pitfall (1) 03-10.viii.1997 • (1) 06-15.vi.1997 • soil sample (1) 14.ix.1997 • (49°35'06"N; 79°17'51"W) in old growth black spruce forest flight-interception trap (1) 03-10.viii.1997 • pitfall (2) 20-27.vii.1997 • soil sample (1) 14.ix.1997 • (49°33'26"N; 79°18'56"W) in mature black spruce forest pitfall (1) 20-27.vii.1997 • (1) 29.vi-06.vii.1997 • (2) 20-27.vii.1997 • soil sample (1) 01.x.1997 • (49°32'41"N; 79°19'00"W) in old growth black spruce forest Berlese sample of mosses (1) 04.vii.1997 • (1) 09.ix.1997 • (2) 10.x.1997 • flight-interception trap (1) 10-17.viii.1997 • Malaise/FIT pan (1) 06-15.vi.1997 • (1) 15-22.vi.1997 • pitfall (1) 17-24.viii.1997 • (49°05'26"N; 79°08'54"W) in mature black spruce forest pitfall (1) 20-27.vii.1997 • (49°01'50"N; 79°08'47"W) in mature black spruce forest flight-interception trap (1) 07-14.ix.1997 • pitfall (1) 20-27.vii.1997 • (49°44'35"N; 79°02'10"W) in burned growth black spruce forest pitfall (1) 10-17.viii.1997 • (1) 20-27.vii.1997 • (1) 29.vi-06.vii.1997 • (1) 31.viii-07.ix.1997 • (2) 28.ix-05.x.1997

85) *Tympanophorus puncticollis* is a rare species (A. Smetana, pers. comm.). Interestingly, a few specimens were collected in the canopy-funnel trap, which suggests a possible relation with the forest canopy.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 19-26.vi.1994 • (1) 03-10.vii.1994 • (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest canopy funnel (1) 30.vi-07.vii.1996 • **Témiscamingue: Lake Labyrinthe** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Berlese sample of mosses of dead balsam fir with mosses (1) 18.ix.1996 • canopy funnel (1) 30.vi-07.vii.1996 • (1) 07-14.vii.1996 • Malaise/FIT pan (1) 16-23.vi.1996 • (1) 30.vi-07.vii.1996 • pitfall (1) 07-14.vii.1996 • **Jamésie (Baie James):** (49°49'03"N; 79°00'06"W) in mature black spruce forest Malaise/FIT pan (1) 20-27.vii.1997

86) *Ischosoma virginiense*. According to the distribution given in Campbell (1991a), the present collection is an interesting range extension to the northwest of the province.

Jamésie (Baie James): (49°44'35"N; 79°02'10"W) in burned black spruce forest pitfall (1) 20-27.vii.1997

87) *Lordithon appalachianus.* According to the distribution given by Campbell (1982), this record is the northernmost for the species in Quebec.

Jamésie (Baie James): (49°32'41"N; 79°19'00"W) in old growth black spruce forest Malaise/FIT pan (1) 27.vii-03.viii.1997

88) *Lordithon facilis.* According to the distribution given by Campbell (1982), this record is the northernmost for the species in Quebec.

Abitibi-ouest: Lake Duparquet: (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 26.vi-03.vii.1994

89) *Lordithon longiceps.* According to the distribution given by Campbell (1982), this record is the northernmost for the species in Quebec.

Jamésie (Baie James): (49°32'41"N; 79°19'00"W) in old growth black spruce forest flight-interception trap (1) 29.vi-06.vi.1997

90) *Lordithon quaesitor.* These records are the northernmost for this rare species (Campbell 1982).

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 14-21.vii.1996 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 05-12.vi.1994 • (4) 12-19.vi.1994 • **Témiscamingue: Lake Labyrinthe**: (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Berlese sample of fungus on dead birch trunk (1) 24.vii.1996 • Malaise/FIT pan (6) 09-16.vi.1996 • (2) 16-23.vi.1996 • (1) 14-21.vii.1996

91) *Sepedophilus occultus,* **new Canadian record**. According to Campbell (1976), the previous northernmost record was from the edge of Lake Ontario in the state of New York. The collection of this species in the boreal forest extends it known distribution of about 1000 km to the north. Anthony Davies confirmed our identifications.

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample of lichen at the basis of birch trunk (1) 19.ix.1996 • Malaise/FIT pan (1) 11-18.ix.1994 • (1) 03-10.ix.1994 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 03-10.ix.1994 • **Témiscamingue: Lake Labyrinthe:** (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 09-16.vi.1996

92) *Tachinus schwarzi.* The present record of this rare species is the northernmost according to distribution given by Campbell (1973, 1988).

Témiscamingue: Lake Labyrinthe: (48°13'35"N; 79°27'47"W) in white cedar/balsam fir forest Malaise/FIT pan (1) 25.viii-01.ix.1996

93) *Tachinus vergatus.* The records of this rare species in the western part of Quebec is an interesting range extension according to distribution given by Campbell (1973, 1975, 1988).

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Malaise/FIT pan (3) 29.v-05.vi.1994 • (1) 12-19.vi.1994 • pitfall (1) 23.v-02.vi.1996 • (48°29'32"N; 79°14'28"W) in mixed forest Malaise/FIT pan (1) 05-12.vi.1994 • (1) 12-19.vi.1994 • (1) 03-11.ix.1994

94) *Tachyporus dispar*. The records of this species are the western most on the eastern part of the continent (Campbell 1979). This introduced species shows the typical pattern of an North America introduction with two entry points, one on each side of the continent (see LeSage and Paquin 2001).

Abitibi-ouest: Lake Duparquet: (48°19'30"N; 79°19'30"W) in white cedar/balsam fir forest Berlese sample of fungi on rotting log (1) 19.ix.1996 • pitfall (1) 22-29.ix.1996 • (48°29'50"N; 79°16'25"W) in deciduous forest emergence cage top (1) 29.v-05.vi.1994 • (1) 12-19.vi.1994 • (1) 26.vi-03.vii.1994 • Malaise/FIT pan (1) 05-12vi.1994 • (2) 12-19.vi.1994 • (1) 03-10.vii.1994 • **Jamésie (Baie James):** (49°43'35"N; 79°17'59"W) in regenerating black spruce forest flight-interception trap (1) 22-29.vi.1997 • (49°35'37"N; 79°17'46"W) in old growth black spruce forest flight-interception trap (1) 06-15.vi.1997 • (49°32'41"N; 79°19'00"W) in old growth black spruce forest Malaise/FIT pan (1) 29.ix-05.x.1997 • (49°49'03"N; 79°00'06"W) in mature black spruce forest Malaise/FIT pan (1) 06-15.vi.1997

95) *Tetratoma concolor*, **new provincial record**. Serge Laplante kindly confirmed our identification.

Jamésie (Baie James): (49°50'01"N; 78°41'12"W) in old growth black spruce forest flight-interception trap (1) 10-17.viii.1997

MORPHOLOGICAL EVIDENCE FOR THE HYBRID *ENALLAGMA EBRIUM* X *HAGENI* (ZYGOPTERA: COENAGRIONIDAE) FROM ONTARIO

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On 18 June 2000, four species of Zygoptera including *Enallagma civile*, *E. cyathigerum*, *E. ebrium,* and *E. hageni.* were collected from Burnside gravel pit pond, 45.2272° N, 75.7780° W, 5 km NE of Richmond, Ottawa, Ontario. This extensive gravel pit pond had been created 10 years earlier. Subsequent examination of the material revealed a single male specimen of a probable hybrid of *E. ebrium* and *E. hageni.*

Drawings of the anal appendages of the putative hybrid and putative parents from the site were prepared with the aid of a camera lucida and intermediate characteristics suggesting a hybrid origin were noted. Additional specimens of the putative parents from other locations were evaluated in order to compensate for potential variation in discriminating characters not evident in the sample from the hybrid location.

The putative hybrid has a bifid superior appendage, although the dorsal arm is much shorter than the ventral arm (Fig. 1D), and a medially directed sub-apical tooth on the inner side as well as a broad terminal surface directed more posteriorly than medially (Fig. 1E, F). Of the four *Enallagma* species found at Burnside pond, only *E. ebrium* has a bifid superior appendage in the male (Fig. 1A), suggesting that it is one of the parents. The other parent is expected to be a species with non-bifid superior appendages, a medially directed sub-apical tooth on the inner side of the superior appendage, and a broad posteriorly directed terminal surface. *Enallagma hageni* has all of these features to a greater extent than does the hybrid (Fig. 1G, H ,I). Since these features are not possessed by *E. ebrium* (Fig. 1A, B, C), it appears that the specimen is not simply a freak of *E. ebrium*, but rather a hybrid between *E. ebrium* and *E. hageni*. These two species are closely related and indistinguishable except through close examination of terminal appendages in the case of males (Fig. 1), and posterolateral margins of mesostigmal plates in females (Westfall and May 1996).

Features to be expected if *E. cyathigerum* was the other parent, such as a narrower humeral stripe and black area on segment 2 isolated from the base of the segment, are not present in the putative hybrid. That *E. civile* is not a parent is suggested by the putative hybrid's relatively long and horizontal inferior appendages and lack of a visible tubercle on the superior appendages in lateral view. In *E. civile* the inferior appendages are shorter than the superior appendages and directed vertically, and the tubercle is distinct in lateral view.

There is a pale tubercle in *E. ebrium* within the claw on the inner dorsal surface of the lower arm and the medially directed terminal edge of the lower arm is thin. On the putative hybrid, the medial terminal edge of the lower arm is not thin-edged, but thick-edged and the tubercle-like tissue appears terminal (on the medial terminal edge of the lower arm) as would be expected in a hybrid involving *E. hageni* that has a terminal tubercle. The terminal tubercle of the hybrid and the medially directed spine (tooth) are best seen in a lateroventral view (Fig. 1F).

Hybrid Odonata are relatively rare. In damselflies (Zygoptera), only 14 specimens are listed by Corbet (1999) and in the large genus *Enallagma*, the only hybrids listed are two specimens of *E. carunculatum* x *civile*. To this may be added the recent reports of *E. anna* x *civile* (Donnelly 2000) and possibly also *E. optimolocus* (Miller and Ivie 1996) which may be *E. anna* x *carunculatum* (Westfall and May 1996).

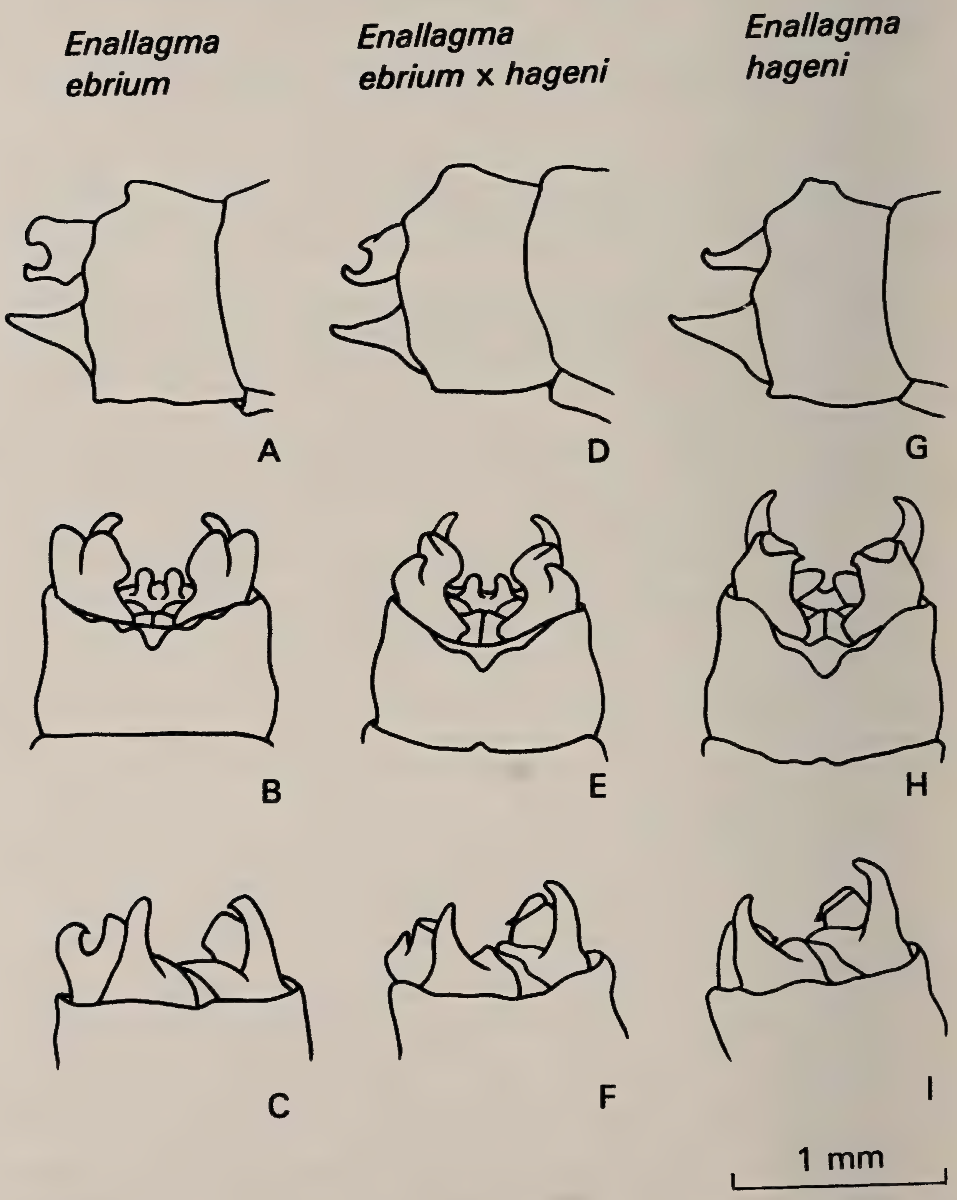

FIGURE 1. Male terminal appendages viewed laterally (A, D, G), dorsally (B, E, H) and lateroventrally (C, F, I) in *Enallagma ebrium* (A, B, C), *E. ebrium* x *hageni* (D, E, F) and *E. hageni* (G, H, I). Camera lucida drawings by P.M. Catling based on material from Burnside Pond, Ottawa, Ontario.

The putative *Enallagma ebrium* x *hageni* specimen has been placed with *E. ebrium* in the Canadian National Collection of Insects, Arachnids, and Nematodes (CNCI, Agriculture and Agrifood Canada, Ottawa).

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BOOK REVIEWS

Tiger Beetles of Alberta. Killers on the Clay, Stalkers on the Sand 2001 *by* John H. Acorn. The University of Alberta Press, Edmonton, Alberta. 120 pp. ISBN 0-88864-345-4

John Acorn has written a superb biology/field guide of the Albertan tiger beetles. It is "intended to be the first volume in a series about Alberta's amazing insects", and sets a high standard for natural history documentaries. The script is entertaining, anecdotal and passionate in places, and is abundantly infused with sparkling colour photography.

The Introduction gives a description of tiger beetles along with the intent of the book "... to bring you under the influence of tiger beetles and their cult of followers", and introduces people and places of the author's early collecting experiences. Among the six chapters that follow, the first two describe important aspects of tiger beetle ecology, and habitats in Alberta. Detailed taxonomic accounts for the 19 known Alberta tiger beetle species are contained in an extensive Chapter Three. The taxa are arranged in their natural groups; each begins with a general statement, and, for every species, a full beetle photo is followed by a common local name, (a practice avoided by most taxonomists so as to eliminate the creation of homonyms or synonyms, though I consider this a minor problem if the common local names are to be applied only to Albertan forms), latinized scientific name, pronunciation for the scientific name, identification, origins of the scientific name, classification, ecology, Cicindelobilia (assorted comments of field experiences and historical notations), geographical distribution maps, and various photos of adults. The remaining three chapters discuss the tiger beetle family and subgroup names, collecting and photography in the field, keeping tiger beetles in terraria, and a sensible plea for the protection and admiration of tiger beetles as well as other invertebrates in our ecosystems.

Two appendices, a checklist of Alberta tiger beetles, and an identification key to the adult tiger beetles of Alberta, and a glossary of terms, and references round out the remaining text. The final section, 'A Gallery of Tiger Beetles' depicting the Albertan forms 1.3 times life-size, serves as a quick identification directory.

The book is of a suitable size for fieldwork, and the sturdy binding and cover should stand up well to regular use. Throughout, the text is given in plain wording, and reliable science, and appears free of grammatical or typographical errors. By any measure Tiger Beetles of Alberta is an important contribution to our understanding of the North American species and their natural groups. It is reasonably priced, and will serve well the varied interests of professionals, amateurs and young collectors of colourful insects.

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Ground Beetles of Connecticut (Coleoptera: Carabidae, excluding Cicindelini): An Annotated Checklist 2001 *by* William L. Krinsky and Michael K. Oliver. State Geological and Natural History Survey, Bulletin 117. 307 pp. ISBN: 0942081-11-0. Paper. $25.95 US.

There is no doubt that the title of this book reflects its content: it is essentially an annotated checklist of the carabid species recorded from Connecticut. Following each species name, the authors provide, by codes (such as VC for very common, C for common, R for rare, Str for stray, SC for species found on the "Connecticut's Endangered, Threatened and Special Concern Species 1998" list), an opinion on the status of the species in Connecticut and, also by codes (such as NE for northeastern United States and Canada), a general indication of the geographic range of the species within North America. The authors also indicate the earliest and latest dates of capture, in any year, of the species in the state, the exact or approximate year when the species was first collected in the state, and a list of collections that house Connecticut material. This is followed by a general description of habitat preference and a list of habitat data found by the authors on Connecticut specimen labels. A map of Connecticut, divided into 169 towns as the basic locality units, is provided on the opposite page highlighting the towns from which the species has been recorded. In addition, each genus, with the exception of those in the subtribe Tachyina, is briefly described. This section, which is the core of the book (pp. 20–289), is preceded (pp. 1–19) by general remarks on Carabidae and a discussion of previous lists of Northeastern beetles. It is followed (pp. 290–307) by a short discussion concerning species abundance, habitat preferences, species decline, introduced species, life cycle patterns, by the literature cited, an alphabetical list of Connecticut Carabidae, and an index. Fifteen plates with colour photographs of 73 species (at least one species for each genus included) are incorporated near the middle of the book.

The information included in this book is of interest for all of us interested in North American Carabidae and the general presentation is of good quality. However, the authors made some decisions that are questionable in my opinion. I believe the tiger beetles should have been included (the authors did not give any reason for ignoring them). There are only 16 species recorded from the state, so the amount of space needed to treat them would have been minimal. The descriptions of genera are only marginally useful. In the absence of keys, novices cannot really identify their specimens to genera, and the experienced carabidologists have no need for such information in a book like this one. The habitus illustrations are not the best I have seen. The specimens used are usually poorly mounted and the pins are visible. A search for better mounted specimens and the use of a specialized software certainly could have improved the quality of the pictures. The genera within each tribe, and the species within each genus, are listed alphabetically. Some may find such presentation convenient, but it really does not give the reader the opportunity to compare easily the available information for related taxa. For example, the three species of *Bracteon* (genus *Bembidion*) found in Connecticut are spread over a number of pages and there is no way, within the book, to find that these species are indeed closely related. I believe it would have been preferable to use subtribes for large tribes, such as Bembidiini and Harpalini, and subgenera for large genera, such as *Bembidion* and *Pterostichus*.

Despite these remarks, which are more of personal preference than of scientific nature, there is no doubt in my mind that the fauna of Connecticut, in term of Carabidae, is now one of the best surveyed in the United States. The book provides a good picture in time of the carabid composition of Connecticut that could be invaluable for assessing biodiversity changes in the future and take actions for environmental management. North American carabidologists will find in this book not only new and useful information about many eastern species but also a model, which could be improved, for similar surveys in other parts of the continent.

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CONTENTS

I. **FROM THE EDITOR** **1**

II. **SUBMITTED PAPERS**

MCCORQUODALE, D.B. — New records and notes on previously reported species of Cerambycidae (Coleoptera) for Ontario and Canada **3–13**

MYLES, T.G. — Three extraction devices for rapid separation of large numbers of live termites (Insecta: Isoptera) **15–25**

MACINTYRE-ALLEN, J.K., C.D. SCOTT-DUPREE, J.H. TOLMAN, C.R. HARRIS and S.A. HILTON — Integrated pest management options for the control of *Acalymma vittatum* (Fabricius), the striped cucumber beetle in southwestern Ontario **27–38**

BOUCHARD, P., K.G.A. HAMILTON and T.A. WHEELER — Diversity and conservation status of prairie endemic Auchenorrhyncha (Homoptera) in alvars of the Great Lakes region **39–56**

PAQUIN, P. and N. DUPÉRRÉ — Beetles of the boreal forest: A faunistic survey carried out in western Québec **57–98**

III. **SUBMITTED NOTES**

CATLING, P.M. — Morphological evidence for the hybrid *Enallagma ebrium* X *hageni* (Zygoptera: Coenagrionidae) from Ontario **99–101**

IV. **BOOK REVIEWS**

FREITAG, R. — Tiger Beetles of Alberta. Killers on the Clay, Stalkers on the Sand. 2001 *by* John H. Acorn **103**

BOUSQUET, Y. — Ground Beetles of Connecticut (Coleoptera: Carabidae, excluding Cicindelini): An Annotated Checklist. 2001 *by* William L. Krinsky and Michael K. Oliver **104–105**

V. **ANNUAL MEETING** . . . . **inside of back cover**

VI. **ENTOMOLOGICAL SOCIETY OF ONTARIO** . . . . **inside of back cover**

VII. **APPLICATION FOR MEMBERSHIP** . . . . **inside of back cover**

VIII. **NOTICE TO CONTRIBUTORS** . . . . **inside of back cover**